



Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

0098⁹088

11-AMRC-0207

SEP 08 2011

Mr. D. A. Faulk, Program Manager
Office of Environmental Cleanup
Hanford Project Office
U.S. Environmental Protection Agency
309 Bradley Boulevard, Suite 115
Richland, Washington 99352

Dear Mr. Faulk:

TRANSMITTAL OF THE 100-BC-1 OPERABLE UNIT INTERIM REMEDIAL ACTION
REPORT, DOE/RL-2011-49, REVISION 0

Attached for your use is the 100-BC-1 Operable Unit Interim Remedial Action Report,
DOE/RL-2011-49, Revision 0. If you have questions, please contact me or your staff may
contact Jamie Zeisloft, of my staff, on (509) 372-0188.

Sincerely,

Mark S. French, Federal Project Director
for the River Corridor Closure Project

AMRC:JHZ

Attachment

cc w/attach:

C. J. Guzzetti, EPA

L. C. Buelow, EPA

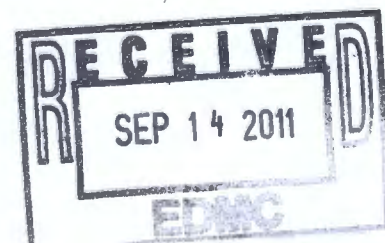
Administrative Record, H6-08

cc w/o attach:

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DOE/RL-2011-49
Rev. 0

100-BC-1 Operable Unit Interim Remedial Action Report



United States
Department of Energy

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100-BC-1 Operable Unit Interim Remedial Action Report

August 2011



United States Department of Energy

P.O. Box 550, Richland, Washington 99352

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ACRONYMS

ACM	asbestos-containing material
ARCL	allowable residual contamination level
BCM	bank cubic meters
BCY	bank cubic yards
CERCLA	<i>Comprehensive Environmental Response, Compensation, and Liability Act of 1980</i>
CFR	<i>Code of Federal Regulations</i>
COC	contaminant of concern
COPC	contaminant of potential concern
cpm	counts per minute
CVP	cleanup verification package
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERC	Environmental Restoration Contractor
ERDF	Environmental Restoration Disposal Facility
ESD	explanation of significant difference
HEPA	high-efficiency particulate air
MTCA	Model Toxics Control Act
NPL	National Priorities List
OU	operable unit
RAG	remedial action goal
RAO	remedial action objective
RCCC	River Corridor Closure Contract
RCRA	<i>Resource Conservation and Recovery Act of 1976</i>
RDR/RAWP	remedial design report/remedial action work plan
RESRAD	RESidual RADioactivity
RI/FS	remedial investigation/feasibility study
RL	U.S. Department of Energy, Richland Operations Office
RMA	radiological material area
ROD	record of decision
ROM	rough order of magnitude
RSVP	remaining sites verification package
RTD	remove, treat, dispose
SAP	sampling and analysis plan
Tri-Parties	U.S. Department of Energy, Richland Operations Office, U.S. Environmental Protection Agency, and Washington State Department of Ecology
Tri-Party Agreement	<i>Hanford Federal Facility Agreement and Consent Order</i>
UST	underground storage tank
VCP	vitricified clay pipe
WAC	<i>Washington Administrative Code</i>
WBS	work breakdown structure

WIDS
WSRF

Waste Information Data System
waste site reclassification form

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

Interim remedial actions in the 100-BC-1 Operable Unit (OU) have been implemented to mitigate potential impacts from hazardous chemical and radioactive releases to the soil column. This report has been prepared in accordance with U.S. Environmental Protection Agency (EPA) guidance in EPA 540-R-98/016, *Close Out Procedures for National Priorities List Sites* (EPA 2000a), to document the remedial actions that were conducted under interim action records of decision (RODs) in the 100-BC-1 OU. This remedial action report is not associated with interim remedial action reports that are normally used to document long-term remedies where it is anticipated that remedial action objectives (RAOs) will be achieved over a long period of time. This report also provides a summary of the background and history of the Hanford Site (inclusive of the 100-BC-1 OU), construction information, costs, and performance data. Information provided herein presents input for future decision making, evaluation of technology, and cost comparison. This report addresses the 100-BC-1 OU waste sites identified in the following decision documents, where RAOs and remedial action goals (RAGs) have been achieved:

- *Interim Action Record of Decision for the 100-BC-1, 100-DR-1 and 100-HR-1 Operable Units, Hanford Site, Benton County, Washington* (EPA 1995)
- *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1 and 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6 and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (EPA 1999)
- *Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2, 100-KR-2 Operable Units (100 Area Burial Grounds), Hanford Site, Benton County, Washington* (EPA 2000b)
- *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington* (EPA 2004)
- *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington* (EPA 2009)
- *Fact Sheet: Annual Listing of Waste Sites Plugged into the Remove, Treat, and Dispose Remedy in the 1999 Interim Action Record of Decision for the 100 Area* (DOE-RL 2011).

The EPA 2009 Explanation of Significant Differences (ESD) authorized that newly discovered waste sites in OUs included in the Remaining Sites ROD that meet the ROD requirements for plug-in or candidate sites should proceed in accordance with the provisions stated in the EPA 2009 ESD without publication of an additional ESD. Additions of plug-in and candidate sites were documented in the Hanford Site Administrative Record and published in

a U.S. Department of Energy, Richland Operations (DOE-RL)-issued annual fact sheet that identified the plug-in and candidate waste sites.

1.2 HANFORD SITE 100 AREA

The Hanford Site is a 1,517-km² (586-mi²) federal facility located in southeastern Washington State along the Columbia River (Figure 1-1). From 1943 to 1990, the primary mission of the Hanford Site was the production of nuclear materials for national defense. In 1989, the 100 Area was one of four areas at the Hanford Site placed on the National Priorities List (NPL) under the authority of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), as amended by the *Superfund Amendments and Reauthorization Action of 1986*. In 1990 the mission of the Hanford Site changed from producing nuclear materials to cleaning up the radioactive and hazardous wastes.

The 100 Area is located along the southern banks of the Columbia River in the northeastern part of the Hanford Site and encompasses an area of approximately 68 km² (26 mi²). The 100-BC Area is one of six reactor areas in the 100 Area and consists of a 3.5 km² (1.4 mi²) area along the southern shore of the Columbia River. The 100-BC Area contains two retired nuclear production reactors, the 105-B and 105-C Reactors. The 105-B Reactor was one of the original three constructed, and the first to start up in September 1944. The reactor was permanently shut down in February 1968 and is currently under consideration for designation as a National Historic Site. The 105-C Reactor operated from 1952 until 1969.

The 100-BC-1 OU is one of three OUs in the 100-BC Area. The 100-BC-1 and 100-BC-2 are source operable units that include solid waste burial grounds, effluent disposal sites, and the associated vadose zone. The 100-BC-5 OU includes the groundwater beneath the source OUs. Only the 100-BC-1 source OU remedial actions are addressed in this report.

1.2.1 100-BC-1 Operable Unit

The 100-BC-1 OU comprises the north portion of the 100-BC Area and is immediately adjacent to the Columbia River. The 105-B Reactor was constructed in 1943 and operated from 1944 through 1968, when it was retired from service. The 100-BC-1 OU contains waste units associated with the original plan facilities constructed to support the 105-B Reactor operations, as well as the cooling water retention facilities to support both 105-B and 105-C Reactors. Waste sites in this OU include solid waste burial grounds, effluent pipelines, dry wells, tanks, outfall structures, retention basins, and liquid waste receiving sites (i.e., unlined trenches, cribs, and french drains).

The map illustrates the Hanford Reach National Monument and its surroundings. The main map shows the Columbia River flowing through the monument, with various townsites and areas labeled. The Hanford Site Boundary is indicated. The map includes a legend, a scale bar, and a north arrow. An inset map shows the location of the Hanford Site within Washington state, near Richland and Vancouver.

Legend:

- River Corridor
- River Corridor Reactor/Operational Areas
- Hanford Reach National Monument
- Central Plateau

Scale:

- 0 2 4 6 8 10 km
- 0 2 4 6 mi

North Arrow: N

Inset Map: Washington state map showing the Hanford Site location near Richland and Vancouver.

Labels on Map: Priest Rapids Dam, Umtanum Ridge, Vermita Bridge, 100-B/C, 100-K, 100-N, 100-D, 100-H, White Bluffs Townsite, 100-F, 100-IU-2, 100-IU-6, Gable Mtn, Gable Butte, 200 West, 200 East, ERDF, Hanford Townsite, Energy Northwest, 300 Area, Yakima River, Pasco, Kennewick, Snake River, To Astoria, OR.

1.2.2 100-BC-2 and 100-BC-5 Operable Units

The 100-BC-2 OU contains waste sites associated with the facilities to support 105-C reactor operations and other waste sites at 100-BC including most of the solid waste burial grounds. The 105-C Reactor, built similar to the 105-DR Reactor completed 2 years earlier, was started up in September 1952. It utilized as many of the existing 105-B Reactor facilities as possible by expanding these facilities and/or cross-tying pipelines between facilities. The most significant shared facilities included the river pump house, the reservoir, and the inert gas system. The reactor was permanently shut down in April 1969 and in situ stabilized in 1998.

The 100-BC-5 OU consists of contaminated groundwater beneath the 100-BC-1 and 100-BC-2 OUs. The 100-BC-5 groundwater area of interest also includes a large section of the 100 Area west of the 100-BC Area. Previous assessments have not identified groundwater conditions that warrant interim remedial measures in the 100-BC-5 OU. Previous and current groundwater monitoring are documented in annual sitewide reports, the most recent being DOE/RL-2010-11, *Hanford Site Groundwater Monitoring and Performance Report: 2009*.

1.3 ENVIRONMENTAL SETTING

The Hanford Site is located within the semiarid Pasco Basin in the northern portion of the Columbia Plateau. Average annual precipitation on the Hanford Site is 16 cm. PNL-10285, *Estimated Recharge Rates at the Hanford Site*, estimated 0.26 to 1.73 cm/yr recharge in the 100 Area. Bedrock beneath the site is basalt of the Columbia River Basalt Group. The top of the basalt in the 100 Areas ranges in elevation from 46 m above sea level near the 100-H Area to 64 m below sea level near the 100-BC Area (the 100-BC Area is approximately 140 to 150 m above sea level).

The Ringold Formation and Hanford formation (informal designation) cover the basalt throughout the 100 Area. These units are dominated by poorly consolidated, river-deposited, well-drained sands, gravels, cobbles, and boulders. The Ringold Formation is an interstratified sequence of unconsolidated clay, silt, sand, and gravel-to-cobble gravel deposited by the ancestral Columbia River. The Hanford formation consists of uncemented gravels, sands, and silts deposited by Pleistocene cataclysmic flood waters.

Groundwater enters the 100-BC Area from upgradient areas along the Columbia River and the gaps between Umtanum Ridge, Gable Butte, and Gable Mountain. Groundwater flows primarily to the north beneath the 100-BC Area and discharges to the Columbia River (DOE/RL-2010-11).

2.0 100-BC AREA BACKGROUND

In anticipation of CERCLA NPL listing of the Hanford Site's 100 Areas in 1989, the EPA, Washington State Department of Ecology (Ecology), and DOE entered into the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989). The Tri-Party Agreement is a legally-binding agreement among the EPA, DOE, and Ecology (Tri-Parties) for the purposes of achieving compliance with the remedial action provisions of CERCLA and with treatment, storage, and disposal unit regulation and corrective action provisions of the *Resource Conservation and Recovery Act of 1976* (RCRA).

2.1 INTEGRATION WITH CERCLA CLEANUP ACTIONS

Source OU cleanup actions in the River Corridor are performed in accordance with several interim action RODs that provide a regulatory framework, establish cleanup objectives, and identify selected remedies. New waste sites identified and accepted in the Waste Information Data System (WIDS) as waste sites by the Tri-Parties may be added to the ROD as "plug-in" sites per the 2009 ESD if they meet the criteria for ROD sites for subsequent characterization and determination for additional remedial action.

2.2 REMEDIAL ACTION DECISIONS

In order to expedite the decision-making process to allow cleanup to begin as soon as possible, in 1991, the Tri-Parties adopted a "bias-for-action" approach for the remediation of the Hanford Site called the *Hanford Past-Practice Strategy* (DOE/RL-91-40). This approach streamlined the remedial investigation/feasibility study (RI/FS) process for contaminated waste sites to allow remediation to begin earlier than is typically allowed under the traditional CERCLA process. As mentioned previously, the decision documents authorizing remediation for waste sites in the 100-BC-1 OU include the following:

- *Interim Action Record of Decision for the 100-BC-1, 100-DR-1 and 100-HR-1 Operable Units, Hanford Site, Benton County, Washington, (Interim Action ROD) (EPA 1995).* This ROD defines remedial action for high priority waste sites liquid effluent disposal site. The selected remedy includes removing contaminated soils, structures, and debris using an observational approach with disposal at the Hanford Site's Environmental Restoration Disposal Facility (ERDF).
- *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1 and 100-HR-2, 100-FR-1, 100-KR-2, 100-IU-2, 100-IU-6 and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington (Remaining Sites ROD) (EPA 1999).* This interim action ROD directs remedial action for waste sites that have been termed "100 Area Remaining Sites for Remove, Treat, and Dispose" because of indicated adverse impacts to human health and the environment. In addition, this interim

action ROD identifies “Candidate 100 Area Remaining Sites for Plug-in of Remove, Treat and Dispose” because information was insufficient to determine if remedial action is needed. This interim action ROD also directs remedial action at proximity, analogous, and discovery waste sites that can be shown to be plugged into the “Remove, Treat, and Dispose” remedy.

- *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2, 100-KR-2, Operable Units (100 Area Burial Grounds), Hanford Site, Benton County, Washington (Burial Grounds ROD) (EPA 2000b).* This interim action ROD defines remedial action for areas used for near-surface disposal of solid wastes containing hazardous substances. The selected remedy includes removing contaminated soils, structures, and debris with disposal at ERDF.
- *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision, Benton County, Washington (EPA 2004).* Identifies newly discovered 100-BC Area waste sites that were added in 1999. These sites were added using the “plug-in” approach to the 100 Area remove, treat, dispose (RTD) remedy.
- *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington (EPA 2009).* This ESD added 99 waste sites that were “plugged in” and remediated in accordance with the Remaining Sites ROD or that have been remediated in accordance with the plug-in approach without prior issuance of an ESD. Also, this ESD added 87 newly discovered waste sites that were candidates for remediation, of which only one was assigned to the 100-BC-1 OU.
- *Fact Sheet: Annual Listing of Waste Sites Plugged into the Remove, Treat, and Dispose Remedy in the 1999 Interim Action Record of Decision for the 100 Areas (DOE/RL 2011).* The 2009 ESD authorized that additions of plug-in and candidate sites will be documented in the Administrative Record and a fact sheet will be published by DOE annually identifying the plug-in and candidate sites that have been added. This fact sheet added 43 waste sites, two that were assigned to the 100-BC-1 OU, that were remediated in accordance with the Remaining Sites ROD or that have been remediated in accordance with the plug-in approach without prior issuance of an ESD. In addition, the fact sheet lists 20 candidate sites that require further evaluation.

The decision documents described above also direct remedial action at waste sites within other 100 Area OUs. However, this report only documents remedial action completed at waste sites in the 100-BC-1 OU.

Candidate sites confirmed not to exceed the RAGs for any constituents are reclassified as “No Action” or “Rejected” (based on quantitative or qualitative data, respectively) per the waste site reclassification guidelines identified in RL-TPA-90-0001, *Tri-Party Agreement Handbook Management Procedures*, Guideline Number TPA-MP-14, “Maintenance of the Waste Information Data System.” Regulator approval is documented on a waste site reclassification form (WSRF), which is accompanied by a regulator-reviewed, site-specific informal report discussing the reasons and justification for reclassification. The WIDS database serves as formal

100-BC Area Background

notification to the public that the site is no longer a candidate for remedial action and does not exceed RAGs and RAOs established in the Remaining Sites ROD (EPA 1999).

Upon demonstration that the RAGs in the applicable interim action ROD have been attained for a given waste site, the status of the waste site is reflected in a WSRF that formally changes the classification status of a waste site in WIDS. In cases where a waste site is shown to meet the RAOs without any remedial actions, it is reclassified in WIDS from an "Accepted" to a "No Action" status. If a waste site meets the RAGs and RAOs specified in an interim action ROD following remedial actions, then the site is reclassified as "Interim Closed Out" in WIDS. The use of the term "close out" in this context refers to individual waste sites and should not be confused with the "close-out reports" used for delisting NPL sites (EPA 2000a).

A total of 73 waste sites in the 100-BC Area are specifically identified in the scope of this report and are listed in Table 2-1. The locations of 100-BC-1 OU waste sites are shown in Figure 2-1.

Table 2-1. 100-BC-1 Operable Unit Waste Sites. (3 Pages)

WIDS Site Code/Name
100-B-2, 181-B Backwash Trench
100-B-3, Hot Thimble Burial Ground
100-B-4, Building Foundation
100-B-5, Effluent Vent Disposal Trench
100-B-7, 100-B Service Water Pipelines
100-B-8, 100-B Area Effluent Pipelines
100-B-10, 107-B Basin Leak and Warm Springs
100-B-11, 115-B/C Caisson Site
100-B-12, Filter Box Radiological Materials Area
100-B-14, 100-B Area Process and Sanitary Sewer Underground Pipelines
100-B-16, Utility Poles and Fixtures Debris Pile
100-B-17, Transite on Columbia River Shoreline at 100-B
100-B-18, 184-B Powerhouse Debris Pile
100-B-19, 100-BC Stained Soil Sites
100-B-20, 1716-B Maintenance Garage Underground Tank
100-B-21, 100-BC Miscellaneous Pipelines
100-B-22, 100-B Water Treatment Facilities and Surrounding Soils
100-B-24, 1904-B1 Spillway
100-B-25, 1904-B2 Spillway
100-B-26, 1904-C Spillway

Table 2-1. 100-BC-1 Operable Unit Waste Sites. (3 Pages)

WIDS Site Code/Name
100-B-27, Sodium Dichromate Spill
100-B-28, 183-C Headhouse to 183-B Pumphouse Sodium Dichromate Transfer Pipeline
100-B-29, Pipe Located Southeast of 183-B Clearwells
100-B-32, Soil Contamination Area Associated With Legacy Waste
100-B-33, Soil Contamination Area 2 Associated With Legacy Waste
116-B-1, 107-B Liquid Waste Disposal Trench
116-B-2, 105-B Storage Basin Trench
116-B-3, 105-B Pluto Crib
116-B-4, 105-B Dummy Decontamination French Drain
116-B-5, 116-B-5 Crib
116-B-6A, 111-B Crib No. 1
116-B-6B, 111-B Crib No. 2
116-B-7, 1904-B-1 Outfall Structure
116-B-9, 104-B-2 French Drain
116-B-10, 108-B Dry Well
116-B-11, 107-B Retention Basin
116-B-12, 117-B Crib
116-B-13, 107-B South Sludge Trench
116-B-14, 107-B North Sludge Trench
116-B-15, 105-B Fuel Storage Basin Cleanout Percolation Pit
116-B-16, 111-B Fuel Examination Tank
118-B-5, Ball 3X Burial Ground
118-B-7, 111-B Solid Waste Burial Site
118-B-9, 104-B-1 Tritium Vault and 104-B-2 Tritium Laboratory
118-B-10, Ball 3X Storage Vault
120-B-1, 105-B Battery Acid Sump
126-B-1, 184-B Power House Ash Pit, 188-B Ash Disposal Area
126-B-2, 183-B Clearwells
126-B-3, 184-B Coal Pit
126-B-4, B Area Brine and Salt Dilution Pits
128-B-1, 100-BC Burning Pit
128-B-2, 100-B Burn Pit #2
128-B-3, 100-B Dump Site

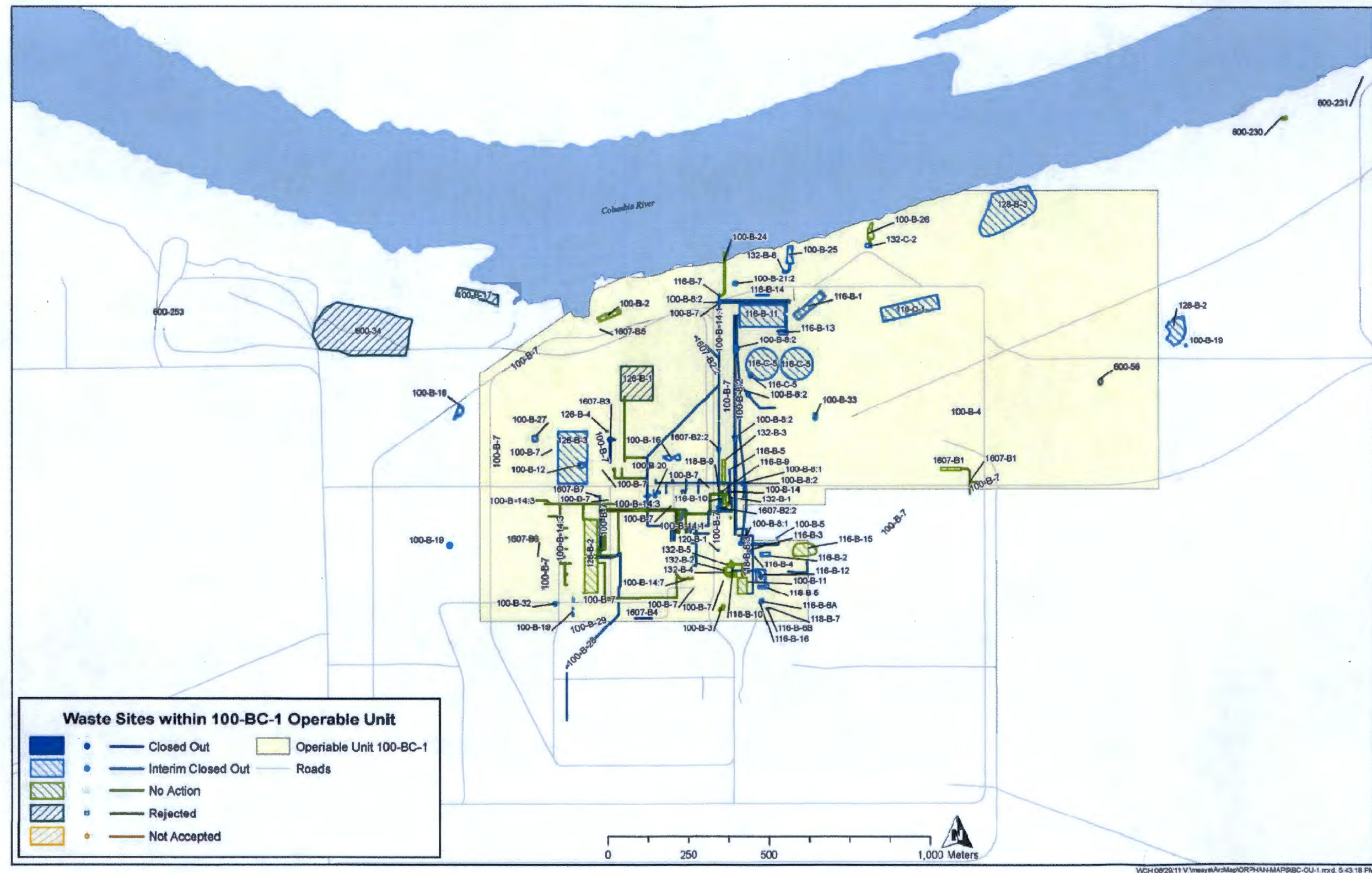
Table 2-1. 100-BC-1 Operable Unit Waste Sites. (3 Pages)

WIDS Site Code/Name
132-B-1, 108-B Tritium Separation Facility
132-B-3, 108-B Ventilation Exhaust Stack Site
132-B-4, 117-B Filter Building
132-B-5, 115-B/C Gas Recirculation Facility
132-B-6, 1904-B-2 Outfall Structure Site
132-C-2, 1904-C Outfall
1607-B1, Septic Tank System, 124-B-1
1607-B2, Septic Tank System, 124-B-2
1607-B3, Septic Tank System, 124-B-3
1607-B4, Septic Tank System, 124-B-6
1607-B7, Septic Tank System, 124-C-1
116-C-1, 107-C Liquid Waste Disposal Trench
116-C-5, 107-C Retention Basins
600-34, 100-B Baled Tumbleweed Disposal Site
600-56, Pre-Hanford Farm Site
600-67, Bruggemann's Fruit Storage Warehouse
600-230, RCRA General Inspection 200Wfy97 Item #4 Historic Disposal Site
600-231, RCRA General Inspection 200Wfy97 Item #5 Historic Disposal Site
600-253, Gravel Pit # 24
600-264, Abandoned Oil Drum

RCRA = Resource Conservation and Recovery Act of 1976

WIDS = Waste Information Data System

Figure 2-1. 100-BC-1 Operable Unit Waste Sites.



NOTE: A total of six accepted waste sites are currently part of the 100-BC-1 OU and are not included in this report. These waste sites are associated with either the 105-B Reactor or the active 100-BC pumphouse/service water line and include the following: 118-B-8, "105-B Reactor Building"; 132-B-2, "105-B Reactor Exhaust Stack"; 1607-B5, "1607-B5 Septic Tank System"; 1607-B6, "1607-B6 Septic Tank System"; 100-B-15, "100-BC River Effluent Pipelines"; and 100-B-34, "B/C Area Pipelines under Active Utilities/Services." These sites will be addressed in the final action ROD.

2.3 EXPOSURE AND LAND-USE ASSUMPTIONS

The reasonably anticipated land use is important in CERCLA remedial actions in determining the appropriate extent of remediation. Future land use affects the types and frequency of exposures to residual contamination for both human and ecological receptors; thereby, influencing the amount of cleanup needed. Decisions on future land use at the Hanford Site had not been made at the time most of the interim action RODs for the 100 Area were issued. In the absence of such decisions, an assumption of "unrestricted use" was used for the 100 Area to select a cleanup remedy and establish cleanup goals, such that future use of the land would not be precluded by contamination left from past Hanford Site operations. Unrestricted surface use was represented by a hypothetical rural-residential scenario. The interim action RODs stated that remediation to this scenario would also be protective of ecological receptors in the 100 Area.

Under the 100 Area unrestricted surface use scenario represented by an individual in a rural-residential setting, a human living in the remediated areas is conservatively assumed to consume crops raised in a backyard garden, meat and milk from locally raised livestock, and meat from game animals and fish. The following exposure pathways are used to consider estimated doses from radionuclides in soil:

- Inhalation
- Soil ingestion
- Ingestion of crops, meat, fish, drinking water, and milk
- External gamma exposure.

Unrestricted land-use cleanup levels for chemicals or nonradionuclides are based on the 1996 *Washington Administrative Code* (WAC) 173-340-740(3) guidance that was in effect at the time the interim action RODs were approved. The exposure pathway for residual nonradiological contamination is from ingestion of contaminated soil.

The final ROD for the 100-BC-1 OU will incorporate current exposure and land-use assumptions through an RI/FS. The RI/FS will incorporate applicable or relevant and appropriate requirements contained in current guidance and regulations to support final remedial action decisions that are protective of human health and the environment. As a result, the assumptions that serve as the basis for establishing cleanup goals may be different from those reflected in the interim action RODs. Section 5.2 provides additional discussion on the final remedial action

decisions for the River Corridor OUs. Once final RAOs have been met for the OU, a final remedial action report will be prepared.

2.4 REMEDIAL ACTION REQUIREMENTS

Implementation of remedial actions at the 100-BC-1 OU waste sites in accordance with interim action RODs required implementation of the selected cleanup remedy to address actual or threatened releases. The major components of the selected RTD remedy include the following:

- Planning and implementation of the remedial action according to an approved remedial design report/remedial action work plan (RDR/RAWP) document
- Stockpiling uncontaminated overburden and use for backfilling excavations when feasible
- Removal of contaminated soil, structures, and associated debris
- Disposal of contaminated materials at ERDF; the Waste Isolation Pilot Plant in Carlsbad, New Mexico; or other disposal facilities approved in advance by the EPA
- Treatment, as necessary, to meet waste acceptance criteria at an acceptable disposal facility
- Recontouring and backfilling of excavated areas and restoring viable habitat by revegetating the impacted area with native species
- Identifying institutional controls to prevent exposure to contamination by limiting land or resource uses if needed
- Demonstrating that residual contamination concentrations are protective of humans and the environment.

As outlined in the 100 Area interim action RODs, RAOs are met by implementing the selected remedy with an “observational approach.” The observational approach consists of two main steps: compilation of available data and the “characterize-and-remediate-in-one-step” methodology. The first step relies on recorded information from historical process operations and information from investigations (e.g., limited field investigations, historical document review, and orphan site evaluations), addressing the nature and extent of contamination. This initial step of characterization is a prerequisite task to field remediation and used to develop an initial understanding of site conditions. The second step of the observational approach proceeds with characterization (i.e., sampling and analysis) and RTD as needed. The candidate waste sites identified in the Remaining Sites ROD do not proceed to RTD if pre-remediation characterization demonstrates that the waste site conditions meet RAGs.

The RTD remedy for the waste sites in the 100-BC-1 OU involved removing contaminated soils, debris, and anomalous waste present within waste site boundaries. The materials exposed during

excavation were monitored for radiological and hazardous chemical constituents as defined in DOE/RL-96-22, *100 Area Remedial Action Sampling and Analysis Plan*, and DOE/RL-2001-35, *100 Area Burial Grounds Remedial Action Sampling and Analysis Plan* (100 Area Burial Grounds SAP). During remediation of known dump sites or burial grounds, extra measures were taken for materials to be sorted for waste disposition. During excavation, soils were monitored for both radiological and chemical constituents. Activities were guided during excavation using data obtained from in situ analyses or in-process sampling using quick-turnaround laboratory analyses working concurrently with excavation.

Remediation proceeded until it was demonstrated through a combination of field screening, in-process sampling, and verification sampling that cleanup goals had been achieved. When completion of remediation was indicated at each waste site, cleanup verification sampling and analysis was performed to verify attainment of cleanup criteria for all contaminants of concern (COCs) and contaminants of potential concern (COPCs). If cleanup verification sampling analytical results indicated that cleanup criteria could not be achieved by direct comparison to RAGs or appropriate modeling, then excavation resumed to remove contamination at locations where RAGs are exceeded. Appropriate locations were resampled with concurrence from the lead regulatory agency and DOE-RL. If necessary, additional remediation was performed until direct comparison to RAGs and appropriate modeling indicated that all RAGs had been attained.

The division of the site excavation into decision units for demonstration that cleanup goals have been met is a function of the applicable RAGs. The direct exposure, groundwater protection, and river protection RAGs are applicable to soils within 4.6 m (15 ft) of the ground surface. This soil interval is referred to as the "shallow zone." The groundwater protection and river protection RAGs are applicable to soils greater than 4.6 m (15 ft) below the ground surface. The soil interval greater than 4.6 m (15 ft) deep is referred to as the "deep zone." If a site meets the direct exposure, groundwater protection, and river protection RAGs before 4.6 m (15 ft), then the entire site was handled as a shallow zone decision unit.

A brief explanation regarding the remedial action decision units and cleanup verification sampling is provided in site closure documents where remediation was required. Discussion regarding the rationale for using a single shallow zone decision unit or dividing the site into separate shallow and deep zone decision units is given. Division of the site into other decision units (e.g., overburden, staging areas, sorting cells, decontamination areas) is discussed as appropriate. Sampling dates and the number of samples collected per decision unit are discussed. If any focused sampling was conducted, a summary of this activity and rationale is also included.

A statistical sampling design with sample locations distributed across decision units is the verification sampling approach preferred in regulatory guidance where the distribution of potential residual soil contamination over the site is uncertain. In focused sampling, process knowledge and professional judgment are used to focus sample collection on locations that are expected to have the highest contamination levels. The evaluation of focused samples is based on maximum values of analytical results. Statistical sampling uses summary statistics for decision making. Focused sampling is often appropriate for confirmatory sampling at remaining

candidate sites and investigation of anomalies in remediation excavations, whereas statistical sampling has most often been used at radioactive liquid effluent sites and at remaining sites following remedial action.

Specific RAOs associated with the selected remedy and the method for achieving the objectives through 100 Area remedial actions are summarized in Table 2-2.

Table 2-2. 100 Area Operable Unit Cleanup Objectives.

Remedial Action Objective	100-BC Area Compliance Methods
Protect human and ecological receptors from exposure to contaminants in soils, structures, and debris by dermal exposure, inhalation, or ingestion of radionuclides, inorganics, or organics.	Achieved through excavation to state of Washington Administrative Code WAC 173-340, "Model Toxics Control Act – Cleanup" levels for organic and inorganic chemical constituents in soil to support unrestricted (residential) use. Achieve human health standards of less than 15 mrem/yr above background for radionuclides in soil.
Control the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions.	<p>Levels of contaminants in soil after remediation do not result in an adverse impact to groundwater that could exceed maximum contaminant levels and nonzero maximum contaminant level goals under the <i>Safe Drinking Water Act of 1974</i> or Method B cleanup levels under the WAC 173-340-720, "Model Toxics Control Act Cleanup Regulations."</p> <p>Levels of contaminants in the soil after remediation do not result in an impact to groundwater and the Columbia River that could exceed the ambient water quality criteria under the <i>Clean Water Act of 1977</i> for protection of fish or Method B cleanup levels under the WAC 173-340-730, "Model Toxics Control Act Cleanup Regulations." Because there are no ambient water quality criteria for radionuclides, maximum contaminant levels from national primary drinking water standards were used.</p> <p>The protection of receptors (aquatic species, with emphasis on salmon) in surface waters were achieved by reducing or eliminating further contaminant loadings to groundwater such that receptors at the groundwater discharge in the Columbia River are not subject to any additional adverse risks.</p>
To the maximum extent practicable, provide the highest degree of protection of human health and the environment through removal and disposal of the mass of contamination such that institutional controls and/or long-term monitoring are not required.	Institutional controls were applied to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]) for sites where residual contamination was present greater than 4.6 m [15 ft] below the surface.

WAC = Washington Administrative Code

2.5 ESTIMATED COST

The rough-order-of-magnitude (ROM) cost estimates are published in the various decision documents identified in Section 2.2. The ROM costs were estimated in present value costs and are considered accurate within a range of plus 50% to minus 30%. These decision documents identify the estimated costs for remediation and disposal, and estimated quantities for the RTD remedy. In addition to the RTD costs, several of the decision documents also estimate costs for confirmatory sampling at candidate waste sites. The estimated ROM costs for remediation and confirmatory sampling of the 100-BC-1 OU waste sites totaled approximately \$208.9 million. Actual remediation costs excluding confirmatory sampling costs totaled \$57.5 million. A discussion regarding the differences in ROM and actual costs is presented in Section 8.4 of this report.

2.6 REMEDIAL DESIGN SUMMARY

The general design and approach for remediation of the 100-BC-1 OU waste site is documented in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP). The 100 Area RDR/RAWP describes the approach employed to remediate the 100-BC-1 OU and other waste sites. The 100 Area RDR/RAWP was prepared as specified in the 100 Area interim action RODs and has received six revisions as regulatory requirements and guidance has evolved, remediation has progressed, and additional waste sites have been included.

3.0 CHRONOLOGY OF EVENTS

A chronology of major events associated with remediation of the 100-BC-1 OU is presented in Table 3-1, beginning with signature of the ROD in 1995 and ending with completion of backfill and revegetation operations in 2010. The chronology includes infrastructure documents, initiation and completion of field operations, and issuance of closeout documents. A summary of the 100-BC-1 OU events by waste site is depicted in Figure 3-1.

Table 3-1. 100-BC-1 Operable Unit Chronology. (6 Pages)

Date	Event
1994	<i>Limited Field Investigation Report for the 100-BC-1 Operable Unit (DOE/RL-93-06)</i>
1995	<i>100 Area Source Operable Unit Focused Feasibility Study (DOE/RL-94-61)</i> <i>Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units, Hanford, Site, Benton County, Washington (EPA 1995)</i> Excavation and loadout of 116-B-4 and 116-B-5 waste sites Verification sampling at 116-B-4 and 116-B-5 Backfill at 116-B-4
1996	<i>Remedial Design Report/Remedial Action Work Plan for the 100 Area (DOE/RL-96-17, Rev. 0)</i> Additional excavation at 116-B-4 Additional verification sampling at 116-B-4 Backfill at 116-B-5 Excavation, loadout, and verification sampling at 116-C-1 Excavation and loadout at 116-C-5
1997	<i>100 Area Remedial Action Sampling and Analysis Plan (DOE/RL-96-22, Rev. 0)</i> Excavation and loadout at 116-B-11 Excavation and loadout of plumes at 116-C-1 Begin test pits (eight total) and collect samples at 116-C-1
1998	<i>Remedial Design Report/Remedial Action Work Plan for the 100 Area (DOE/RL-96-17, Rev. 1)</i> <i>100 Area Remedial Action Sampling and Analysis Plan (DOE/RL-96-22, Rev. 1).</i> <i>Tri-Party Agreement Handbook Management Procedures, (RL-TPA-90-0001, Rev. 0)</i> <i>Waste Site Reclassification Form 98-007 for the 126-B-1 Ash Pit</i> Excavation and loadout at 116-B-1 Excavation and loadout complete at 116-B-11 Finish test pit and backfill, verification sampling, site backfill and revegetation at 116-C-1 Finish excavation and loadout at 116-C-5 Begin verification sampling at 116-C-5 Excavation, loadout, and verification sampling at 116-B-13 Excavation, loadout, and verification sampling at 116-B-14

Table 3-1. 100-BC-1 Operable Unit Chronology. (6 Pages)

Date	Event
1999	<p><i>Cleanup Verification Package for the 116-B-1 Process Effluent Trench (BHI 1999a)</i></p> <p><i>Cleanup Verification Package for the 116-B-11 Retention Basin (BHI 1999b)</i></p> <p><i>Cleanup Verification Package for the 116-B-13 South Sludge Trench (BHI 1999c)</i></p> <p><i>Cleanup Verification Package for the 116-B-14 North Sludge Trench (BHI 1999d)</i></p> <p><i>Cleanup Verification Package for the 116-C-1 Process Effluent Trench (BHI 1999e)</i></p> <p><i>Cleanup Verification Package for the 116-C-5 Retention Basin (BHI 1999f)</i></p> <p><i>Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County Washington (EPA 1999)</i></p> <p>Finish verification sampling at 116-C-5</p> <p>Verification sampling at 116-B-11</p> <p>Finish excavation and loadout at 116-B-1; verification sampling completed</p> <p>Excavation, loadout, and verification sampling at 116-B-2</p> <p>Excavation, loadout, and verification sampling at 116-B-3</p> <p>Continued remediation and loadout at 116-B-4; verification sampling complete</p> <p>Excavation, loadout, and verification sampling at 116-B-6A/116-B-16</p> <p>Excavation, loadout, and verification sampling at 116-B-6B</p> <p>Excavation, loadout, and verification sampling at 116-B-9</p> <p>Excavation, loadout, and verification sampling at 116-B-10</p> <p>Excavation, loadout, and verification sampling at 116-B-12</p>
2000	<p><i>100 Area Burial Grounds Focused Feasibility Study Report (DOE/RL-98-18)</i></p> <p><i>100 Area Remedial Action Sampling and Analysis Plan (DOE/RL-96-22, Rev. 2)</i></p> <p><i>Remedial Design Report/Remedial Action Work Plan for the 100 Area (DOE/RL-96-17, Rev. 2)</i></p> <p><i>Cleanup Verification Package for the 116-B-2 Fuel Storage Basin Trench (BHI 2000a)</i></p> <p><i>Cleanup Verification Package for the 116-B-3 Pluto Crib (BHI 2000b)</i></p> <p><i>Cleanup Verification Package for the 116-B-4 French Drain (BHI 2000c)</i></p> <p><i>Cleanup Verification Package for the 116-B-6A Crib and 116-B-16 Fuel Examination Tank (BHI 2000d)</i></p> <p><i>Cleanup Verification Package for the 116-B-6B Crib (BHI 2000e)</i></p> <p><i>Cleanup Verification Package for the 116-B-9 French Drain (BHI 2000f)</i></p> <p><i>Cleanup Verification Package for the 116-B-10 Dry Well/Quench Tank (BHI 2000g)</i></p> <p><i>Cleanup Verification Package for the 116-B-12 Seal Pit Crib (BHI 2000h)</i></p> <p><i>Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, and 100-KR-2 (100 Area Burial Grounds) Operable Units, Hanford Site, Benton County, Washington (EPA 2000b)</i></p>

Table 3-1. 100-BC-1 Operable Unit Chronology. (6 Pages)

Date	Event
2001	<p><i>100 Area Burial Grounds Remedial Action Sampling and Analysis Plan (DOE/RL-2001-35)</i></p> <p><i>100 Area Remedial Action Sampling and Analysis Plan (DOE/RL-96-22, Rev. 3)</i></p> <p><i>Remedial Design Report/Remedial Action Work Plan for the 100 Area (DOE/RL-96-17, Rev. 3)</i></p> <p><i>Waste Site Reclassification Form 2001-015 for 100-B-12 Filter Box Storage</i></p> <p>Excavation and loadout at 100-B-8:1</p> <p>Contaminated filters removed from 100-B-12; no verification sampling required</p> <p>Excavation and loadout at 116-B-7</p> <p>Excavation and loadout at 132-B-6</p> <p>Excavation and loadout at 132-C-2</p>
2002	<p><i>Cleanup Verification Package for the 116-B-7, 132-B-6, and 132-C-2 B/C Outfalls (BHI 2002)</i></p> <p><i>Remedial Design Report/Remedial Action Work Plan for the 100 Area (DOE/RL-96-17, Rev. 4)</i></p> <p><i>Waste Site Reclassification Form 2001-021 for the 100-B-10 Site</i></p> <p>Verification sampling begins at 100-B-8:1</p> <p>Excavation and loadout at 100-B-8:2</p> <p>Verification sampling at 116-B-7</p> <p>Verification sampling at 132-C-2</p>
2003	<p><i>Cleanup Verification Package for the 100-B-5 Effluent Vent Disposal Trench (BHI 2003)</i></p> <p><i>Waste Site Reclassification Form 2003-008 for 100-B-3 Hot Thimble Burial Ground</i></p> <p><i>Waste Site Reclassification Form 2003-010 for 132-B-4 Filter Building C Area</i></p> <p><i>Waste Site Reclassification Form 2003-011 for 132-B-3 B Reactor Stack</i></p> <p><i>Waste Site Reclassification Form 2003-027 for 132-B-5 Gas Recirculation Building</i></p> <p><i>Waste Site Reclassification Form 2003-044 for 132-B-1 Tritium Facility</i></p> <p><i>Waste Site Reclassification Form 2003-052 for 116-B-15 Storage Basin Percolation Pit</i></p> <p>Excavation, loadout, and verification sampling at 100-B-5</p> <p>Excavation, loadout, and verification sampling complete at 100-B-8:1</p> <p>Excavation, loadout complete, and verification sampling complete at 100-B-8:2</p> <p>Confirmatory sampling at 100-B-14:1/2/3/5/6/7</p> <p>Test pits (four) and confirmatory sampling at 116-B-15</p> <p>Excavation, staging, and loadout at 118-B-5</p> <p>Test pits (four) and confirmatory sampling at 118-B-9</p> <p>Excavation and loadout at 118-B-10</p> <p>Confirmatory sampling at 100-B-11</p> <p>Confirmatory sampling at 120-B-1</p> <p>Excavation, staging, and loadout at 126-B-3</p> <p>Confirmatory sampling at 1607-B2</p> <p>Excavation, loadout, and verification sampling at 1607-B7</p>

Table 3-1. 100-BC-1 Operable Unit Chronology. (6 Pages)

Date	Event
2004	<p><i>Cleanup Verification Package for the 100-B-8:1 100-B/C South Effluent Pipelines (BHI 2004a)</i></p> <p><i>Cleanup Verification Package for the 100-B-8:2 North Effluent Pipelines (BHI 2004b)</i></p> <p><i>Cleanup Verification Package for the 118-B-5 Burial Ground (BHI 2004c)</i></p> <p><i>Cleanup Verification Package for the 118-B-10 Burial Ground (BHI 2004d)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-11 115-B/C Caisson, Sump Drywell, Tank, and Caisson Valve Pit Site (BHI 2004e)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-14:3 West Process Sewer Pipelines Set (BHI 2004f)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-14:5 West Sodium Dichromate and Sodium Silicate Lines (BHI 2004g)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-14:6 Powerhouse Pipeline Site (BHI 2004h)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-14:7 185-B/190-B Sump and Pipeline Site (BHI 2004i)</i></p> <p><i>Remaining Sites Verification Package for the 118-B-9, 104-B-1 Tritium Vault and 105-B-2 Tritium Laboratory (104-B2-Storage Building) Site (BHI 2004j)</i></p> <p><i>Explanation of Significant Difference for the 100 Area Remaining Sites Interim Remedial Action Record of Decision, Benton County, Washington (EPA 2004)</i></p> <p><i>Waste Site Reclassification Form 2004-008 for 100-B-14:4 Cooling Water Pipes and Tunnels</i></p> <p><i>Waste Site Reclassification Form 2004-104 for 100-B-2, 181-B Backwash Trench</i></p> <p><i>Waste Site Reclassification Form 2004-099 for the 118-B-7 Burial Ground</i></p> <p>Excavation, staging, and loadout at 100-B-16</p> <p>Verification sampling at 118-B-5</p> <p>Test trenches (two), test pit (one), and confirmatory sampling at 118-B-7</p> <p>Verification sampling at 118-B-10</p> <p>Excavation, staging, and loadout at 126-B-3</p> <p>Excavation and loadout at 128-B-2</p> <p>Excavation and loadout at 128-B-3</p>
2005	<p><i>100 Area Remedial Action Sampling and Analysis Plan (DOE/RL-96-22, Rev. 4).</i></p> <p><i>Remedial Design Report/Remedial Action Work Plan for the 100 Area (DOE/RL-96-17, Rev. 5)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-16 Utility Poles and Fixture Debris Pile (BHI 2005)</i></p> <p>Confirmatory sampling, excavation, and loadout at 100-B-14:2</p> <p>Verification sampling and additional excavation at 100-B-16</p> <p>Finish loadout at 126-B-3</p> <p>Finish excavation and loadout; verification sampling at 128-B-2</p> <p>Additional remediation at 128-B-3</p> <p>Verification sampling at 1607-B2</p>

Table 3-1. 100-BC-1 Operable Unit Chronology. (6 Pages)

Date	Event
2006	<p><i>Cleanup Verification Package for the 1607-B7 Septic Tank System (BHI 2006)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-20, 1716-B Maintenance Garage Underground Tank (WCH 2006a)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-21:1 Subsite (100-B/C Miscellaneous Pipelines DS-100BC-016 and DS-100-BC-022) (WCH 2006b)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-22:1 Pipelines and Associated Soils (WCH 2006c)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-24 Spillway (WCH 2006d)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-26 Spillway (WCH 2006e)</i></p> <p><i>Remaining Sites Verification Package for the 120-B-1, 105-B Battery Acid Sump (WCH 2006f)</i></p> <p><i>Remaining Sites Verification Package for the 126-B-3, 184-B Coal Pit Dumping Area (WCH 2006g)</i></p> <p><i>Remaining Sites Verification Package for the 128-B-2, 100-B Burn Pit #2 Waste Site (WCH 2006h)</i></p> <p><i>Remaining Sites Verification Package for the 128-B-3 Burn Site (WCH 2006i)</i></p> <p><i>Waste Site Reclassification Form 2006-041 for 600-230 RCRA General Inspection Disposal Site</i></p> <p>Test pit and confirmatory sampling at 100-B-24</p> <p>Test pit and confirmatory sampling at 100-B-25</p> <p>Test pit and confirmatory sampling at 100-B-26</p> <p>Verification sampling and additional excavation/loadout at 100-B-14:2</p> <p>Excavation, loadout, verification sampling, and backfill at 120-B-1</p> <p>Verification sampling at 128-B-3</p> <p>Verification sampling at 1607-B2</p>
2007	<p><i>Explanation of Significant Difference for the Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2, and 100-KR-2 Operable Units (100 Area Burial Grounds) (EPA 2007)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-14:1 Process Sewer (WCH 2007a)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-18, 184-B Powerhouse Debris Pile (WCH 2007b)</i></p> <p><i>Remaining Sites Verification Package for the 1607-B2 Septic System and 100-B-14:2 Sanitary System (WCH 2007c)</i></p> <p><i>Remaining Sites Verification Package for the 126-B-2, 183-B Clearwells (WCH 2007d)</i></p> <p>Test pit and confirmatory sampling at 1607-B1</p> <p><i>Remaining Sites Verification Package for the 1607-B1 Septic Tank System (WCH 2007e)</i></p>
2008	<p><i>Remaining Sites Verification Package for the 100-B-21:2 Subsite (100-B/C Discovery Pipeline DS-100BC-002) (WCH 2008)</i></p>

Table 3-1. 100-BC-1 Operable Unit Chronology. (6 Pages)

Date	Event
2009	<p><i>100 Area Remedial Action Sampling and Analysis Plan (DOE/RL-96-22, Rev. 5)</i></p> <p><i>Remedial Design Report/Remedial Action Work Plan for the 100 Area (DOE/RL-96-17, Rev. 6)</i></p> <p><i>Explanation of Significant Difference for the 100 Area Remaining Site Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington (EPA 2009)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-19, 100-B/C Stained Soil Sites and 100-B/C Chemical Contaminated Surface Soil Areas (WCH 2009a)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-32 Soil Contamination Area Associated with Legacy Waste, SCA #1 (WCH 2009b)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-33 Soil Contamination Area 2 Associated with Legacy Waste (WCH 2009c)</i></p>
2010	<p><i>Fact Sheet: Annual Listing of Waste Sites Plugged into the Remove, Treat and Dispose Remedy in the 1999 Interim Action Record of Decision for the 100 Area (DOE-RL 2011)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-21:4 Pipeline From the 105-C Reactor to the 116-C-2B Sump (WCH 2010a)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-22:2, 100-B Water Treatment Facilities (WCH 2010b)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-25 Overflow Spillway (132-B-6 Outfall) (WCH 2010c)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-27 Sodium Dichromate Spill (WCH 2010d)</i></p> <p><i>Remaining Sites Verification Package for the 100-B-28, 183-C Headhouse to the 183-B Pumphouse Sodium Dichromate Transfer Pipeline (WCH 2010e)</i></p>

BHI = Bechtel Hanford, Inc.

DOE = U.S. Department of Energy

DOE/RL = U.S. Department of Energy, Richland Operations

EPA = U.S. Environmental Protection Agency

NPL = National Priorities List

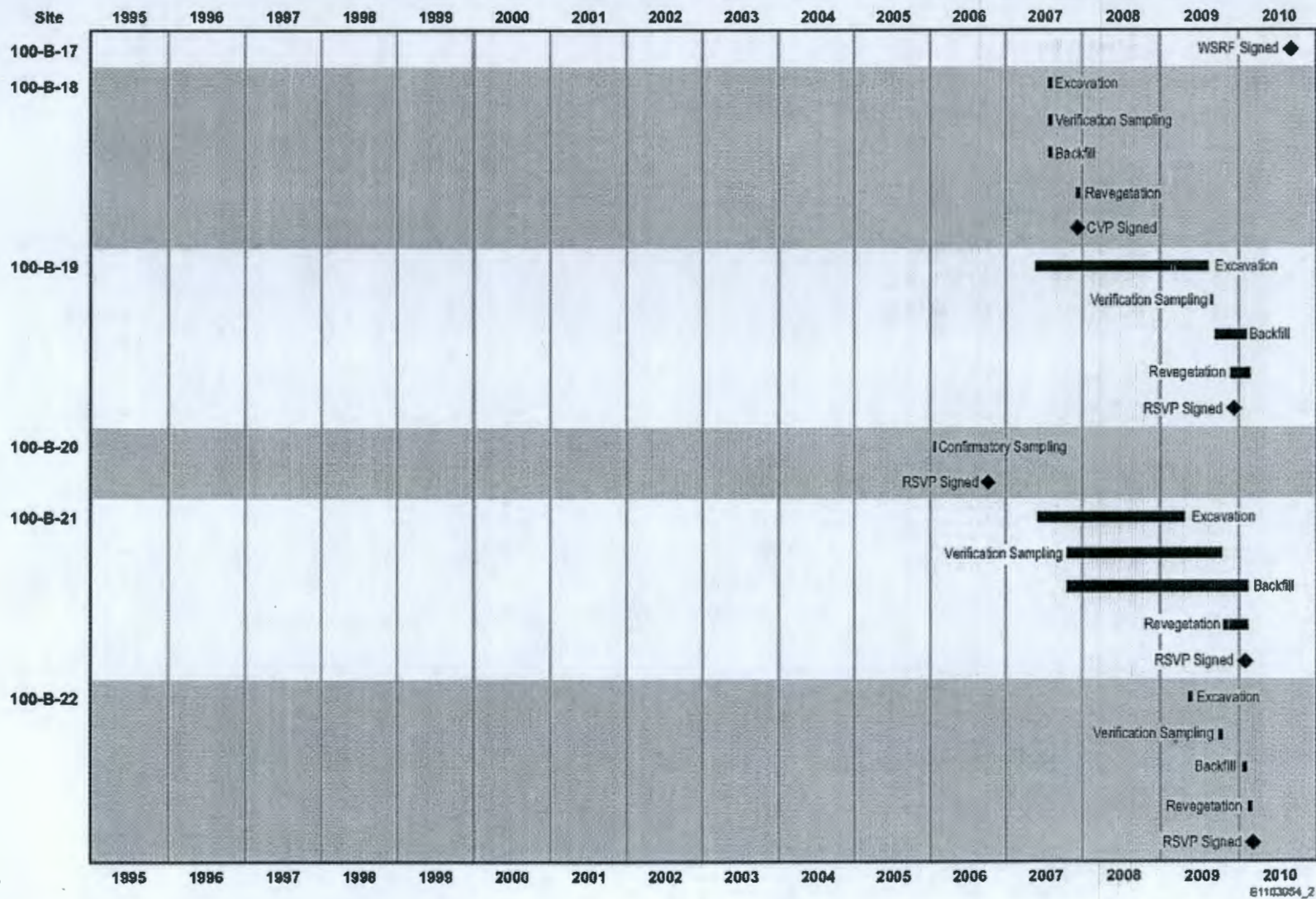
SSNF = suspect spent nuclear fuel

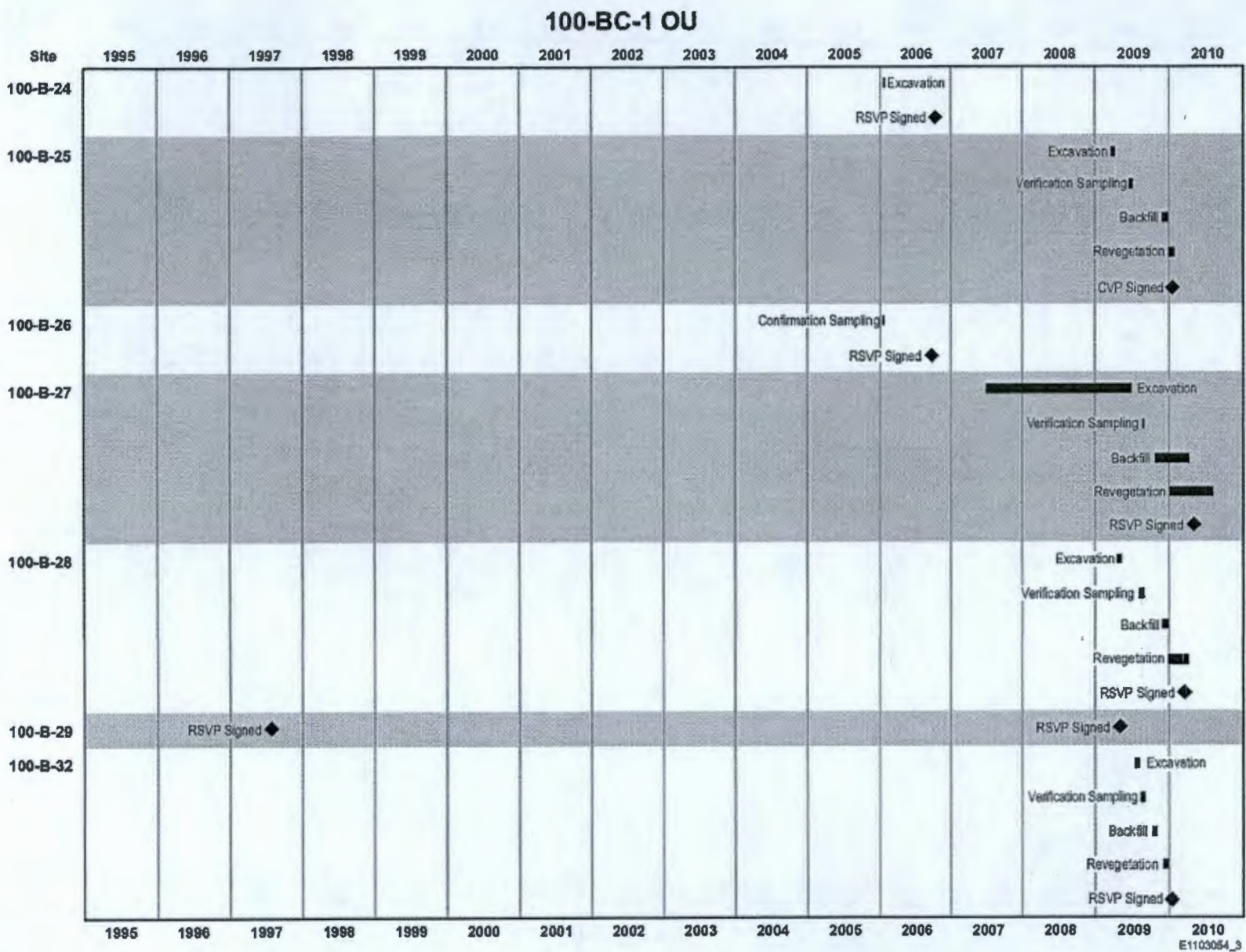
WCH = Washington Closure Hanford

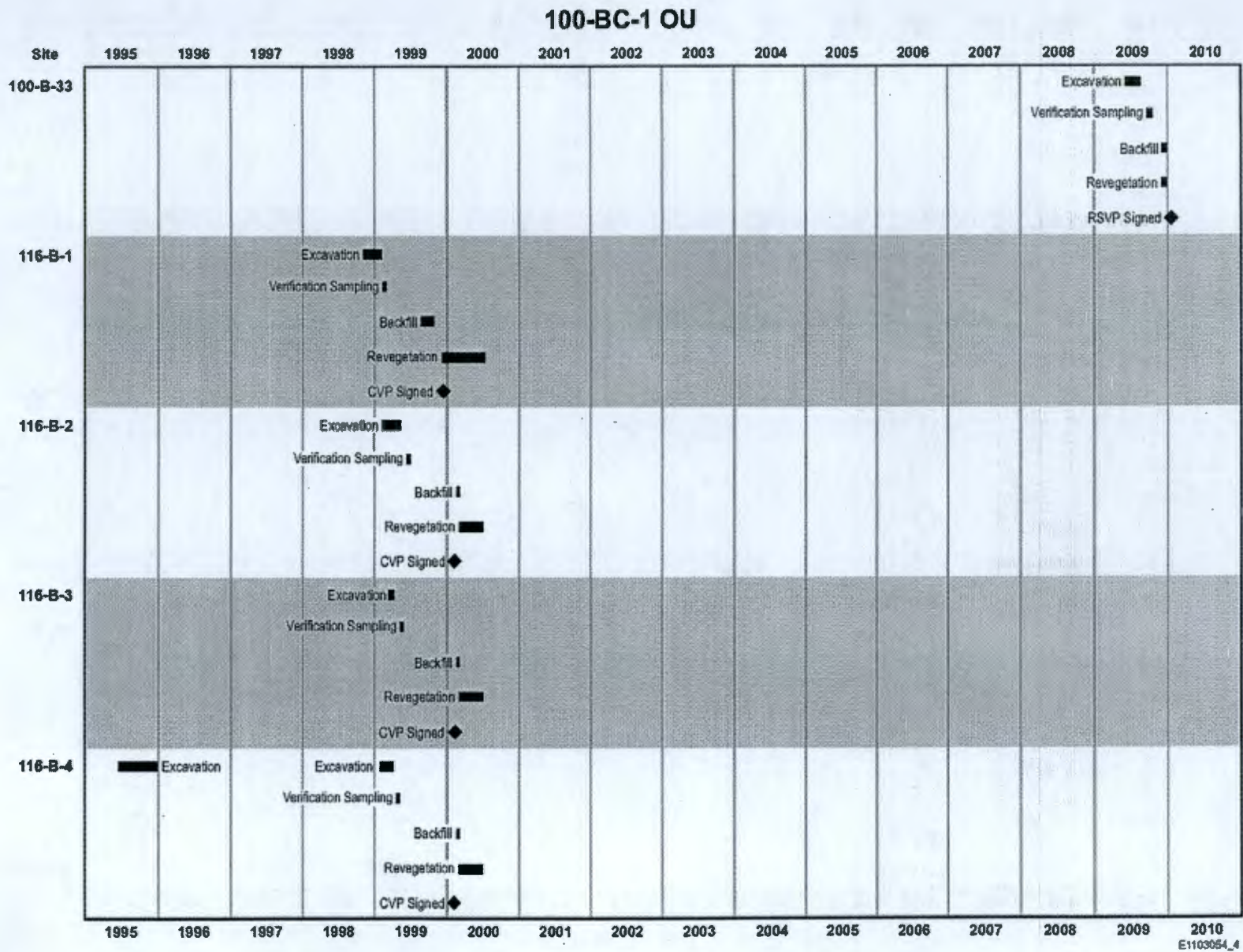
100-BC-1 OV

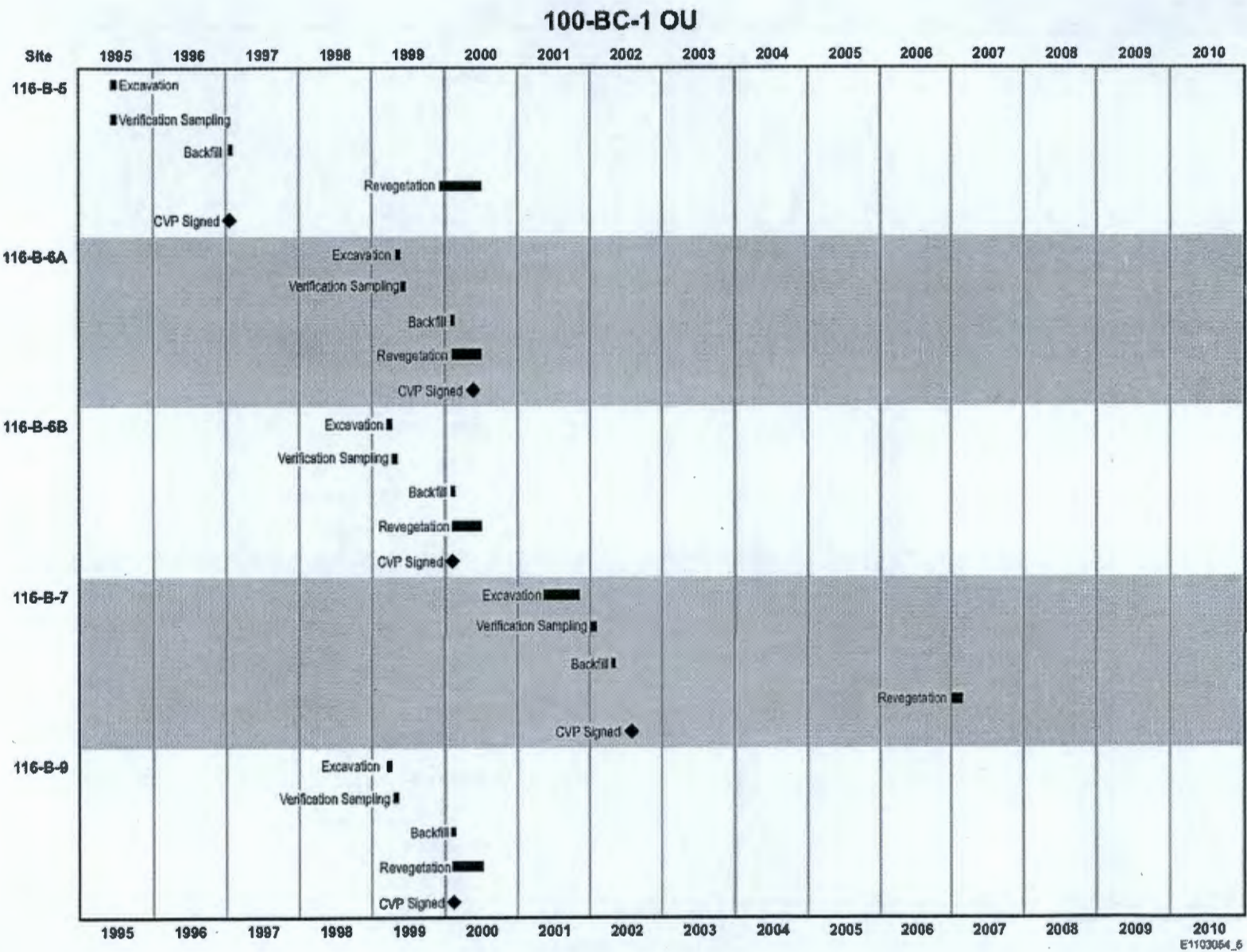


100-BC-1 OU

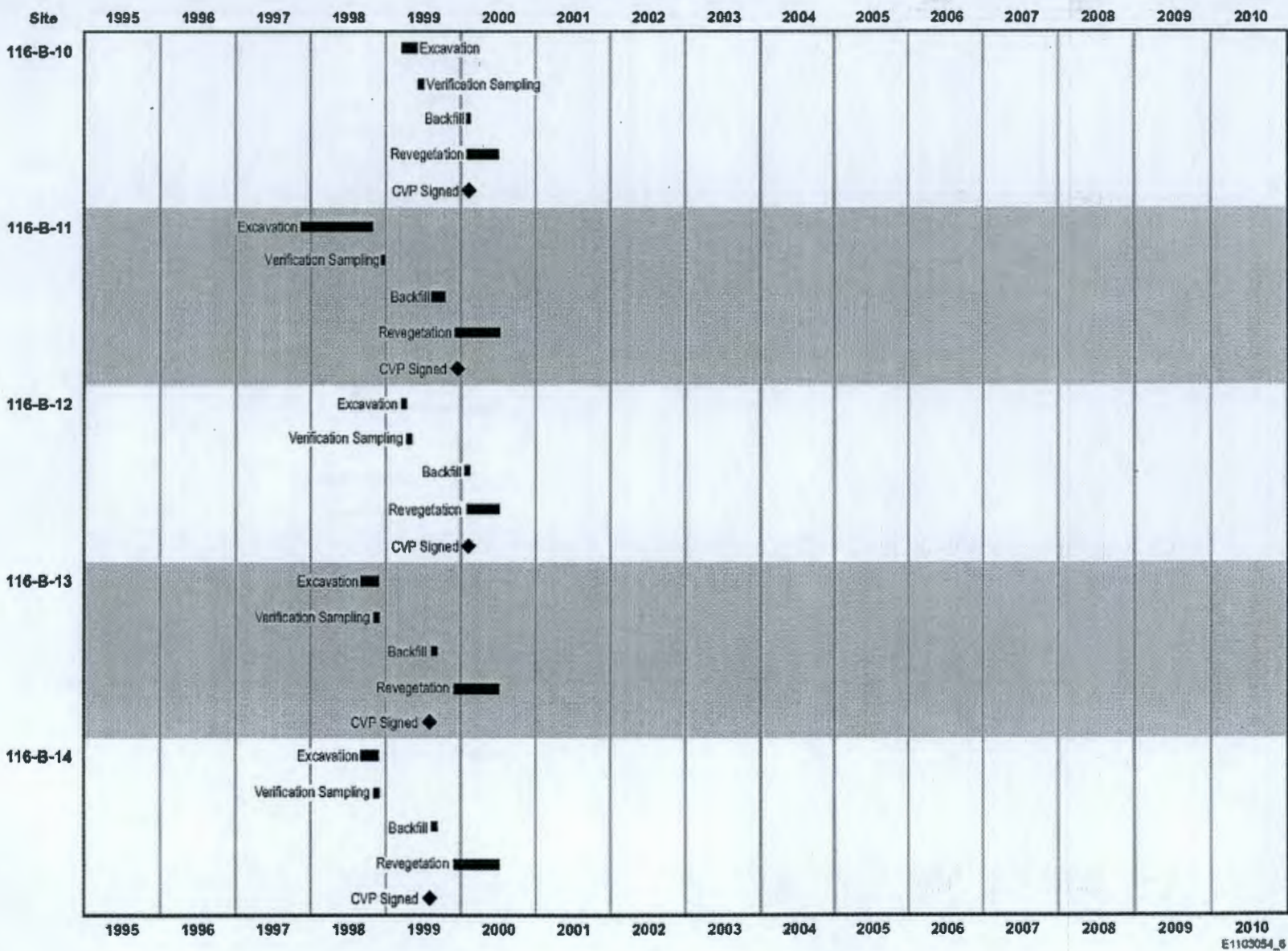




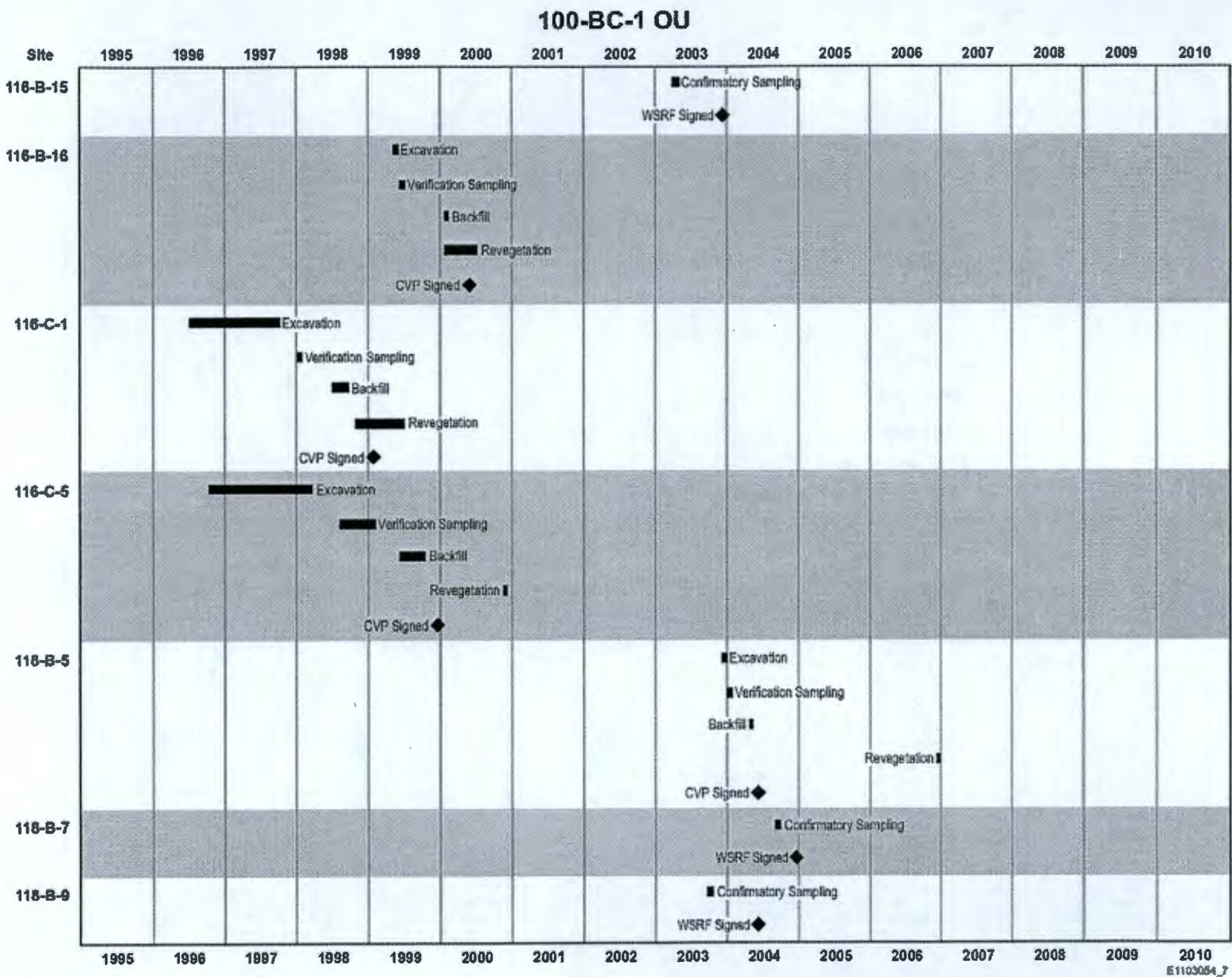




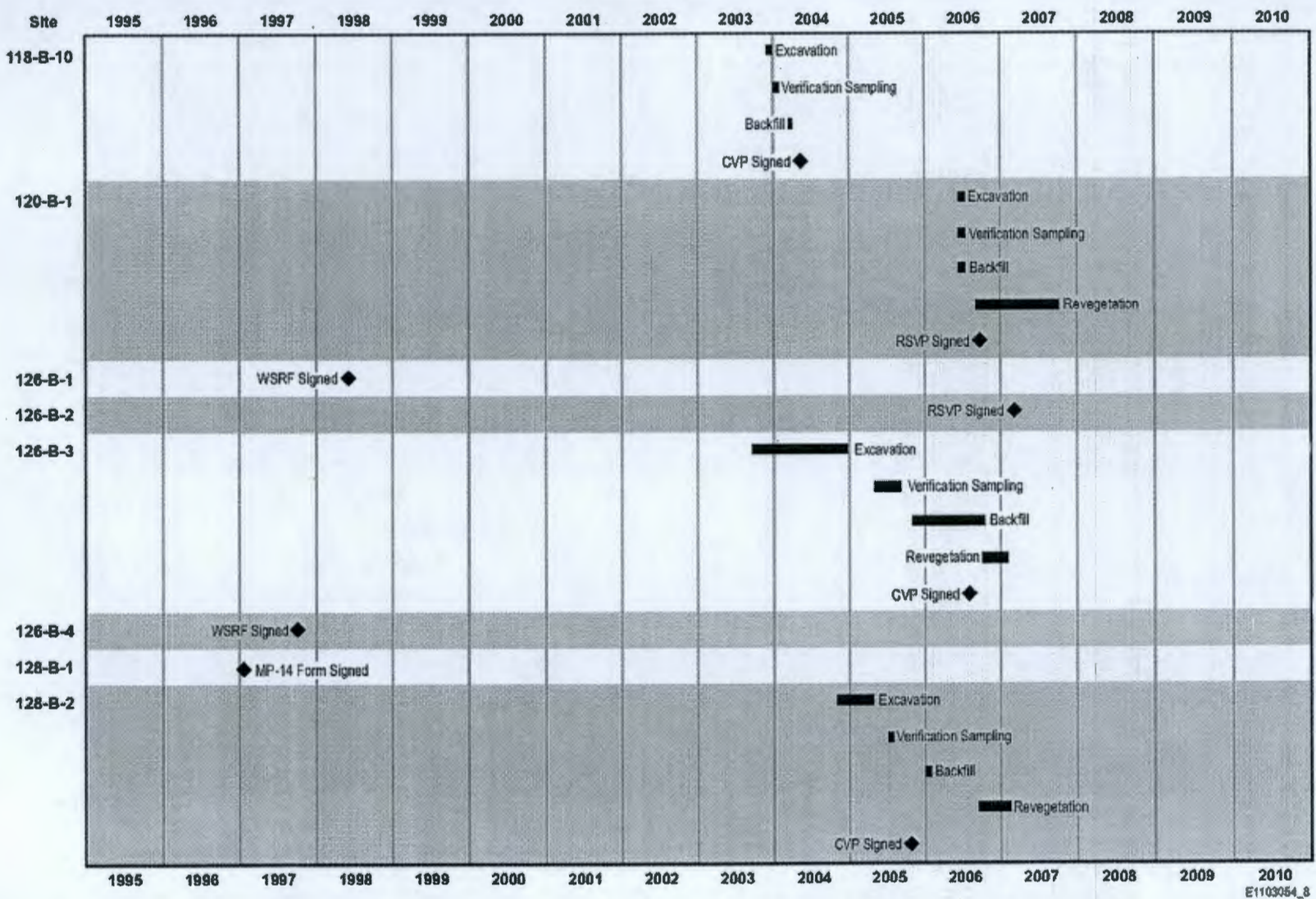
100-BC-1 OU



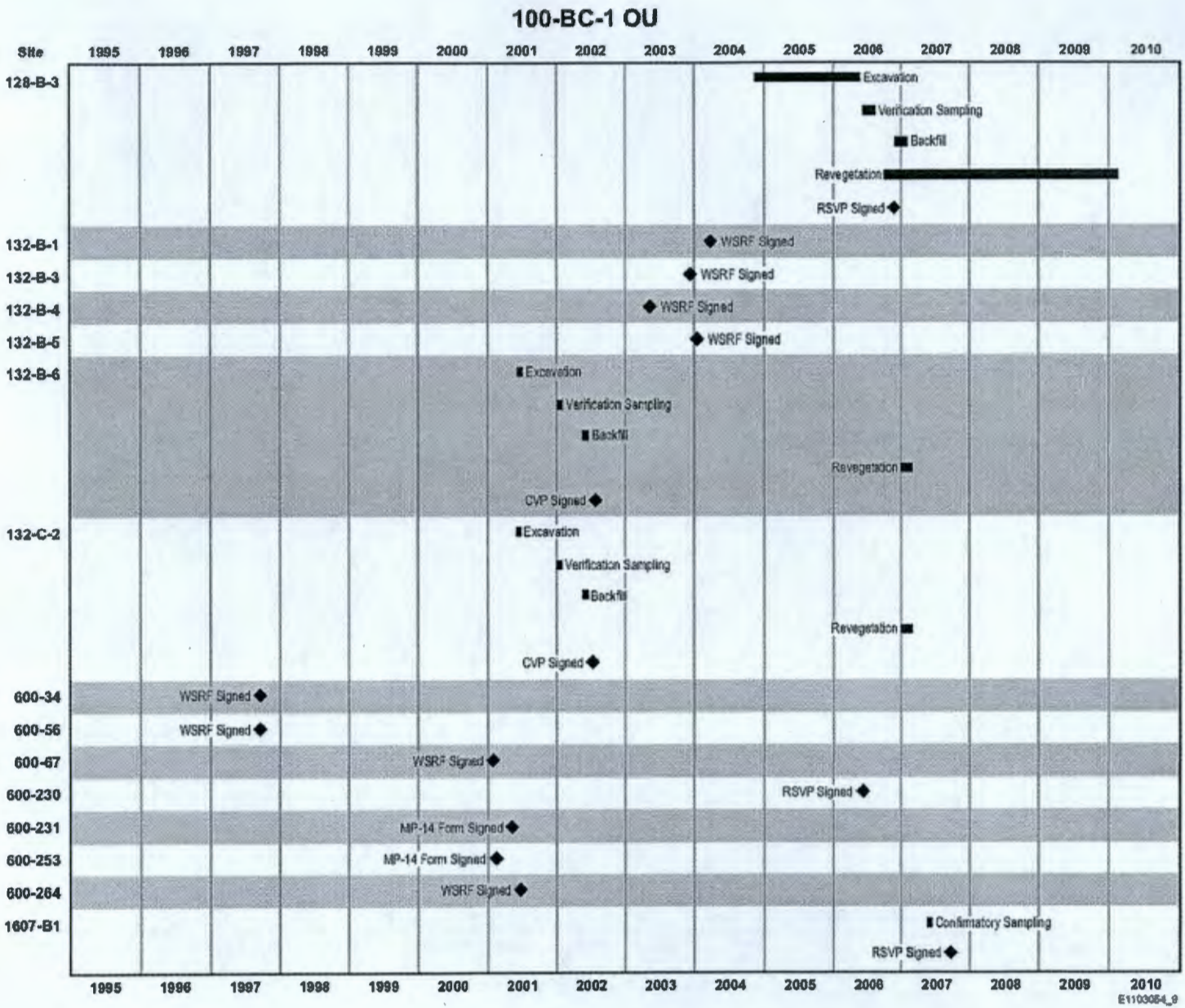
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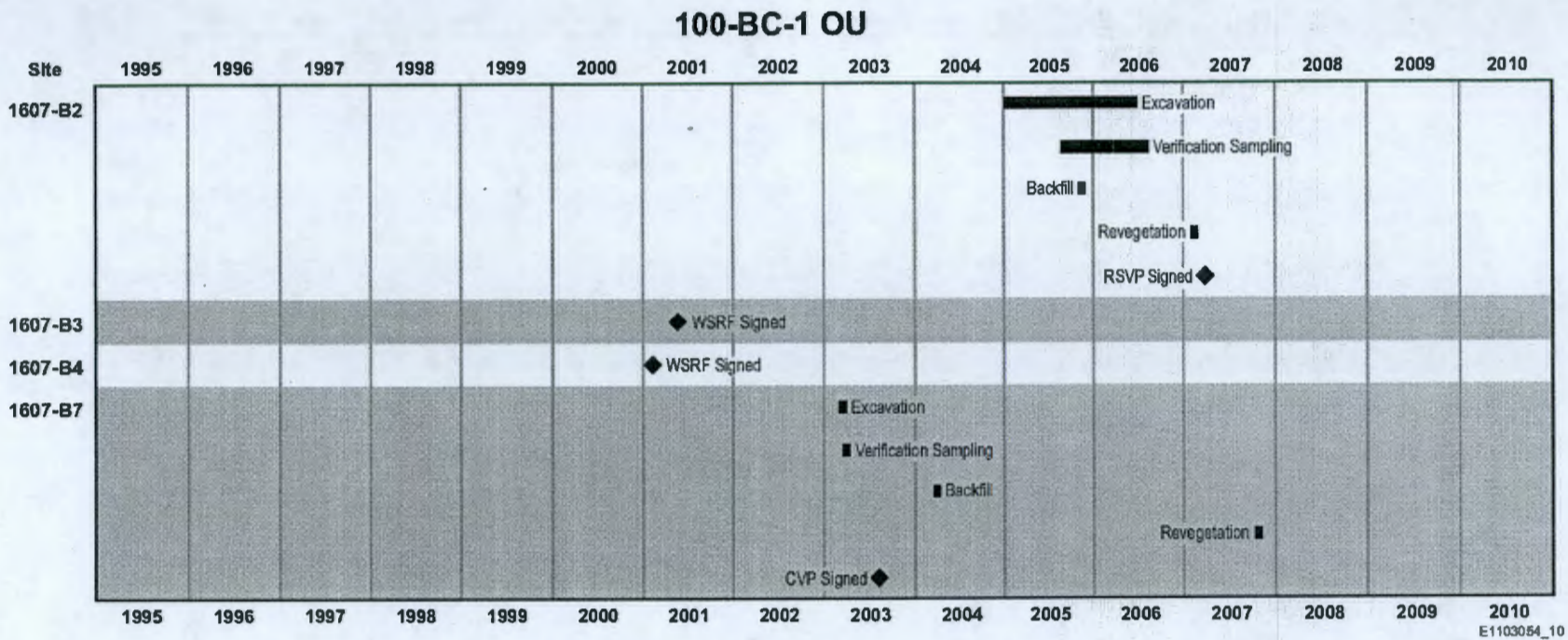


100-BC-1 OU



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4.0 CONSTRUCTION ACTIVITY SUMMARY

Field operations supporting remedial actions at the 100-BC-1 OU began in 1995 and were completed in 2010. The work was performed under several remedial action subcontracts. The cleanup actions resulted in the disposal of more than 1,226,384 metric tons (1,351,857 US tons) of contaminated soil and debris at ERDF from the 100-BC-1 OU. Summaries of the remedial action approach and waste disposal activities for each waste site are presented in Tables 4-1 and 4-2, respectively. Table 4-3 lists identified waste sites that did not require remedial action or were rejected as waste sites. Detailed information about each waste site and related construction activities is presented in the following subsections.

Table 4-1. Remedial Action Approach. (3 Pages)

WIDS Site Code	Site Type	WIDS Site Name and Aliases	Excavation Approach	Personal Protective Equipment
100-B-5	Trench	Effluent Vent Disposal Trench, 116-B-9, 105-B Effluent Vent Trench	Direct load	Level D
100-B-8	Radioactive process sewer	100-B Area Effluent Pipelines	Direct load	Level D
100-B-12	Storage	Filter Box Radiological Materials Area	Direct load	Level D
100-B-14	Process sewer	100-B Area Process and Sanitary Sewer Underground Pipelines	Direct load	Level D
100-B-16	Dumping area	Utility Poles and Fixtures Debris Pile	Stockpile, sort, loadout	Level D
100-B-18	Dumping area	184-B Powerhouse Debris Pile	Direct load and 55-gal drums	Level D
100-B-19	Unplanned release	100-BC Stained Soil Sites, 100-BC Chemical Contaminated Surface Soil Areas	Direct load	Level D
100-B-20	Maintenance shop	1716-B Maintenance Garage Underground Tank	B-25 boxes	Level B, D
100-B-21	Process sewer	100-BC Miscellaneous Pipelines	Direct load	Level B, D
100-B-22	Foundation	100-B Water Treatment Facilities and Surrounding Soils	Stockpile, loadout	Level D
100-B-25	Outfall	1904-B2 Spillway, Flume from Outfall Structures 132-B-6	Stockpile, loadout	Level D
100-B-27	Unplanned release	Sodium Dichromate Spill	Stockpile, loadout	Level D
100-B-28	Product piping	183-C Headhouse to 183-B Pumphouse Sodium Dichromate Transfer Pipeline	Drain/drum liquids, stockpile, sort, loadout	Level C, D

Table 4-1. Remedial Action Approach. (3 Pages)

WIDS Site Code	Site Type	WIDS Site Name and Aliases	Excavation Approach	Personal Protective Equipment
100-B-32	Unplanned release	Soil Contamination Area Associated With Legacy Waste	Direct load	Level D
100-B-33	Unplanned release	Soil Contamination Area 2 Associated With Legacy Waste	Stockpile, loadout	Level D
116-B-1	Trench	107-B Liquid Waste Disposal Trench, Process Effluent Trench	Direct load	Level D ^a
116-B-2	Trench	105-B Storage Basin Trench, B-Storage Basin Crib	Direct load	Level D ^a
116-B-3	Crib	105-B Pluto Crib	Direct load	Level D ^a
116-B-4	French drain	105-B Dummy Decontamination French Drain, 105-B Dummy Decontamination Disposal Crib	Direct load	Level D ^a
116-B-5	Crib	116-B-5 Crib, 116-B-5 Trench, 108-B Crib	Direct load ^a	Level D ^a
116-B-6A	Crib	111-B Crib No. 1, 116-B-6-1	Direct load	Level D ^a
116-B-16	Storage tank	111-B Fuel Examination Tank		
116-B-6B	Crib	111-B Crib No. 2, 116-B-6-2	Direct load	Level D ^a
116-B-7	Outfall	1904-B-1 Outfall Structure	Direct load	Level D
132-B-6		1904-B-2 Outfall Structure Site		
132-C-2		1904-C Outfall, 116-C-4		
116-B-9	French drain	104-B-2 French Drain	Direct load	Level D
116-B-10	Dry well	108-B Dry Well, Quench Tank	Direct load	Level D ^a
116-B-11	Retention basin	107-B Retention Basin	Direct load	Level D
116-B-12	Crib	117-B Crib, 117-B Seal Pit Crib	Direct load	Level D ^a
116-B-13	Trench	107-B South Sludge Trench, 116-B-8, 107-B #2 Grave, Basin Sludge Burial Pit	Direct load	Level D ^a
116-B-14	Trench	107-B North Sludge Trench, 107-B Liquid Waste Disposal Trench No. 1, 116-B-2, 107-B #1 Grave	Direct load	Level D ^a
118-B-5	Burial ground	Ball 3X Burial Ground	Stockpile, sort, loadout	Level B, C, D
118-B-10	Storage tank	Ball 3X Storage Vault	Stockpile, sort, loadout	Level C, D
120-B-1	Sump	105-B Battery Acid Sump	Direct load	Level D
126-B-3	Dumping area	184-B Coal Pit	Stockpile, stage, sort, loadout	Level B, C, D
128-B-2	Burn pit	100-B Burn Pit #2	Stockpile, sort, loadout	Level B, C, D
128-B-3	Burn pit	100-B Dump Site, 128-B-3 Coal Ash and Demolition Waste Site, 128-B-3 Burning Pit Site, 600-57	Stockpile, sort, loadout	Level D

Table 4-1. Remedial Action Approach. (3 Pages)

WIDS Site Code	Site Type	WIDS Site Name and Aliases	Excavation Approach	Personal Protective Equipment
1607-B2	Septic tank	1607-B2 Septic Tank System, 124-B-2, 1607-B2 Sanitary Sewer System	Direct load	Level D
1607-B3	Septic tank	1607-B3 Septic Tank System, 124-B-3, 1607-B3 Sanitary Sewer System	Direct load	Level D
1607-B4	Septic tank	1607-B4 Septic Tank System, 124-B-6, 1607-B4 Sanitary Sewer System	Direct load	Level D
1607-B7	Septic tank	1607-B7 Septic Tank System, 124-C-1, 1607-B7 Sanitary Sewer System	Direct load	Level D
116-C-1	Trench	107-C Liquid Waste Disposal Trench	Direct load	Level D
116-C-5	Retention basin	116-C-5 Retention Basins, 107-C Retention Basins	Direct load	Level D

^a Information was not available. The excavation approach and/or PPE used during waste site remediation were assumed based on analogous waste site approaches.

PPE = personal protective equipment

WIDS = Waste Information Data System

Table 4-2. Environmental Restoration Disposal Facility Waste Disposal Summary for the 100-BC-1 Operable Unit. (3 Pages)

WIDS Site Code	Site Type	Mass of Contaminated Soil/Debris Removed (Direct Disposal) (US tons)	Hazardous or Mixed Soil (Stabilization) (US tons)	Hazardous or Mixed Debris (Macroencapsulation) (US tons)	Total Mass Disposed to ERDF ^a (US tons)
100-B-5	Trench	17,950	0	0	17,950
100-B-8	Radioactive process sewer	357,198	0	0	357,198
100-B-12	Storage	0	0	0	0 ^b
100-B-14	Process sewer	37,643.7	0	3.4	37,647.1
100-B-16	Dumping area	1,869.8	0	0.5	1,870.3
100-B-18	Dumping area	154.7	0	0	154.7
100-B-19	Unplanned release	13,821.1	0	0	13,821.1
100-B-20	Maintenance shop	0	0	0	0 ^b
100-B-21	Process sewer	1,043.2	0	0.93	1,044.1
100-B-22	Foundation	83.5	0	0	83.5
100-B-25	Outfall	6,652	0	0	6,652
100-B-27	Unplanned release	30,193.6	670.8	0.1	30,864.5
100-B-28	Product piping	2,596.7	0	0	2,596.7

**Table 4-2. Environmental Restoration Disposal Facility Waste Disposal
Summary for the 100-BC-1 Operable Unit. (3 Pages)**

WIDS Site Code	Site Type	Mass of Contaminated Soil/Debris Removed (Direct Disposal) (US tons)	Hazardous or Mixed Soil (Stabilization) (US tons)	Hazardous or Mixed Debris (Macroencapsulation) (US tons)	Total Mass Disposed to ERDF ^a (US tons)
100-B-32	Unplanned release	0.01	0	0	0.01
100-B-33	Unplanned release	685	0	0	685
116-B-1	Trench	47,436	0	0	47,436
116-B-2	Trench	10,354	0	0	10,354
116-B-3	Crib	269	0	0	269
116-B-4	French drain	9,590	0	0	9,590
116-B-5	Crib	122.4	0	0	122.4
116-B-6A	Crib	4,691	0	900	5,591
116-B-16	Storage tank				
116-B-6B	Crib	259	0	0	259
116-B-7					
132-B-6	Outfall	18,996	0	0	18,996
132-C-2					
116-B-9	French drain	254	0	0	254
116-B-10	Dry well	763	0	0	763
116-B-11	Retention basin	182,109	0	0	182,109
116-B-12	Crib	9,586	0	0	9,586
116-B-13	Trench	6,989	0	0	6,989
116-B-14	Trench	4,183	0	0	4,183
118-B-5	Burial ground	5,563	0	0.1	5,563.1
118-B-10	Storage tank	293	0	0	293
120-B-1	Sump	70.1	0	0	70.1
126-B-3	Dumping area	122,720.8	0	0.4	122,721.2
128-B-2	Burn pit	13,994.6	0	0.04	13,994.6
128-B-3	Burn pit	46,160.7	103.6	0	46,264.3
1607-B2	Septic tank	41,455.3	0	0	41,455.3
1607-B3	Septic tank	0	0	0	0 ^c
1607-B4	Septic tank	0	0	0	0 ^c
1607-B7	Septic tank	218	0	0	218
116-C-1	Trench	107,514	0	0	107,514

Table 4-2. Environmental Restoration Disposal Facility Waste Disposal Summary for the 100-BC-1 Operable Unit. (3 Pages)

WIDS Site Code	Site Type	Mass of Contaminated Soil/Debris Removed (Direct Disposal) (US tons)	Hazardous or Mixed Soil (Stabilization) (US tons)	Hazardous or Mixed Debris (Macroencapsulation) (US tons)	Total Mass Disposed to ERDF ^a (US tons)
116-C-5	Retention basin	246,695	0	0	246,695
Totals		1,350,177.2	774.4	905.4	1,351,857

^a Identified waste quantities were obtained from remaining sites verification packages/cleanup verification packages or the Waste Management Information System.

^b No waste quantities were generated. The residual concentrations at the waste site meet the remedial action objectives specified in the interim action records of decision.

^c Tank was not removed. Backfilled with rubble or clean material.

ERDF = Environmental Restoration Disposal Facility

WIDS = Waste Information Data System

Table 4-3. Not Accepted, No Action, or Rejected Waste Sites in the 100-BC-1 Operating Unit. (2 Pages)

WIDS Site Code	WIDS Site Name and Aliases	WIDS Site Reclassification Status
100-B-2	181-B Backwash Trench, Backwash Trench, Undocumented Liquid Waste Site, Miscellaneous Stream #73	No Action
100-B-3	Hot Thimble Burial Ground, Undocumented Solid Waste Site	No Action
100-B-4	Building Foundation, Undocumented Solid Waste Site	Not Accepted
100-B-7	100-B Service Water Pipelines, 100-B Clean Water Pipelines	Not Accepted
100-B-10	107-B Basin Leak and Warm Springs	No Action
100-B-11	115-B/C Caisson Site, 115-B/C Sump, 115-B/C Drywell, 115-B Tank, 115-B/C Caisson Valve Pit	No Action
100-B-17	Transite on Columbia River Shoreline at 100-B	Rejected
100-B-24	1904-B1 Spillway (Flume), 100-B-15:1 Flumes from Outfall Structures 116-B-7, 132-B-6, 132-C-2	No Action
100-B-26	1904-C Spillway, 100-B-15:1 Flumes from Outfall Structures 116-B-7, 132-B-6, 132-C-2	No Action
100-B-29	Pipe Located Southeast of 183-B Clearwells	Not Accepted
116-B-15	105-B Fuel Storage Basin Cleanout Percolation Pit, 105-B Fuel Storage Discharge Pond, 105-B Pond	No Action
118-B-7	111-B Solid Waste Burial Site	Rejected
118-B-9	104-B-1 Tritium Vault and 104-B-2 Tritium Laboratory, 104-B2 Storage Building	No Action
126-B-1	184-B Power House Ash Pit, 188-B Ash Disposal Area	Rejected

Table 4-3. Not Accepted, No Action, or Rejected Waste Sites in the 100-BC-1 Operating Unit. (2 Pages)

WIDS Site Code	WIDS Site Name and Aliases	WIDS Site Reclassification Status
126-B-2	183-B Clearwells	No Action
126-B-4	B Area Brine and Salt Dilution Pits, 126-B-4 Brine Pit, 184-B Salt Dissolving Pit and Brine Pump House	Rejected
128-B-1	100-BC Burning Pit, 100-B Burning Pit	Not Accepted
132-B-1	108-B Tritium Separation Facility	No Action
132-B-3	108-B Ventilation Exhaust Stack Site, 108-B Tritium Pilot Facility, Ventilation Exhaust Stack Site	No Action
132-B-4	117-B Filter Building	No Action
132-B-5	115-B/C Gas Recirculation Facility	No Action
1607-B1	1607-B1 Septic Tank System, 124-B-1, 1607-B1 Sanitary Sewer System	No Action
600-34	100-B Baled Tumbleweed Disposal Site	Rejected
600-56	Pre-Hanford Farm Site, Undocumented Solid Waste Site	Rejected
600-67	Bruggemann's Fruit Storage Warehouse	Rejected
600-230	RCRA General Inspection 200WFY97 Item #4 Historic Disposal Site	No Action
600-231	RCRA General Inspection 200WFY97 Item #5 Historic Disposal Site	Not Accepted
600-253	Gravel Pit # 24, Pit 24	Not Accepted
600-264	Abandoned Oil Drum	Rejected

RCRA = Resource Conservation and Recovery Act of 1976

WIDS = Waste Information Data System

4.1 100-B-2, 181-B BACKWASH TRENCH

This site was approximately 50 m (164 ft) southeast of the 181-B Pumphouse and received filtered backwash water via a 30.5-cm (12-in.) diameter line from the pumphouse. Since no hazardous or radioactive contaminants were included in the backwash process, this site was reclassified as "No Action."

4.2 100-B-3, HOT THIMBLE BURIAL GROUND**4.2.1 History**

The 100-B-3 Hot Thimble Burial Ground was located south of the 105-B Reactor and west of the southwest corner of the 115-B Building. The vertical thimble that was placed at this site in 1952 was removed prior to 1956.

Construction Activity Summary

4.2.2 Investigation

Based on process knowledge, the COCs that would have been the residual contamination remaining in the excavation after removal of the vertical thimbles are manganese-54, cobalt-60, and zinc-65. Calculations determined that the COCs would have decayed away in the 51 years since burial (approximately 10 half-lives for the longest-lived of the three, cobalt-60). A 2003 geophysical survey of the area showed no evidence of the thimble remaining.

4.2.3 Statement of Protectiveness

The 100-B-3 Hot Thimble Burial Ground required no further action to meet the cleanup standards established in the interim action ROD. The site will allow future rural-residential use and is protective of groundwater and the Columbia River.

4.3 100-B-4, BUILDING FOUNDATION

The site, which was approximately 762 m (2,500 ft) northeast of the 105-B Reactor building, was an 8.5- by 13-m (28- by 43-ft) rectangular area encircled by large stones neatly stacked about .3 m (1 ft) high. The surrounding area appears to have been cleared of large stones and plowed. The site was determined most likely to be the remains of a pre-Hanford farm building. No wastes appeared to be involved and no hazardous substances were indicated, resulting in a classification of "Not Accepted."

4.4 100-B-5, EFFLUENT VENT DISPOSAL TRENCH

4.4.1 History

The 100-B-5 waste site, also known as the 116-B-9 105-B Effluent Vent Trench, was not a planned or constructed waste disposal site. The site was the result of reactor cooling water effluent leakage from a vent pipe located at a junction box of the 105-B and 105-C Reactor effluent pipelines. The leakage followed the contour of the ground surface running north of the junction box before percolating into the ground. The site was not classified as an unplanned release, since the leakage occurred multiple times over a period of at least 2 years from 1954 to 1956. The 100-B-5 waste site and associated junction box were located approximately 100 m (330 ft) east of the 105-B Reactor building. Since there was not a structure associated with the 100-B-5 waste site, the general site location was based on sampling data from *Radiological Characterization of the Retired 100 Areas* (UNI 1978).

In addition to the 100-B-5 waste site, portions of the 100-B-8 Reactor cooling water effluent pipelines beneath the site were also remediated.

4.4.2 Excavation Operations

Remedial action at the 100-B-5 waste site was conducted in May 2003. Excavation of the 100-B-5 waste site involved removing the overburden materials, removing sections of the 100-B-8 Reactor effluent pipelines, removing a pipeline junction box, and removing contaminated soil. Contaminated materials, including the pipeline sections and concrete junction box, were disposed of at ERDF.

At the conclusion of excavation activities, the elevation of the bottom of the excavation was at 135.5 m (444.4 ft). The excavation had an approximate area of 4,450 m² (47,900 ft²) and a depth of approximately 8.5 m (27.9 ft). Approximately 16,320 metric tons (17,950 US tons) of material from the site were disposed of at ERDF.

4.4.3 Verification Sampling

Cleanup verification samples were collected in May 2003. The 100-B-5 waste site consisted of shallow zone and deep zone decision units. The shallow zone decision unit contained 3 decision subunits that were divided into 12 sampling areas. The deep zone decision unit was divided into three sampling areas. One composite cleanup verification sample was collected from each sample area. Each verification sample was a composite formed by combining soil collected at four randomly selected nodes within each sampling area.

4.4.4 Statement of Protectiveness

The sample results confirm that remedial action at the 100-B-5 waste site has achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified in WIDS as "Interim Closed Out." The remaining soils at the 100-B-5 waste site have been sampled, analyzed, and evaluated. The results of this effort indicate that the materials from the 100-B-5 waste site containing COCs at concentrations exceeding RAGs have been excavated and disposed of at ERDF. These results indicate that residual concentrations in the shallow zone will support future land uses that can be represented (or bounded) by a rural-residential scenario and that residual concentrations throughout the site do not pose a threat to groundwater or the Columbia River. The acceptability of unrestricted direct exposure to deep zone soils has not been demonstrated; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are required.

4.5 100-B-7, 100-B SERVICE WATER PIPELINES

The site includes the clean water upstream pipelines for the 100-B Area including those supplying raw, fire, export, and sanitary water. Since no hazardous or radioactive substances were associated with any of these service water pipelines, the site was classified as "Not Accepted."

Construction Activity Summary

4.6 100-B-8, 100-B AREA EFFLUENT PIPELINES

For the purpose of this report and to be consistent with project close-out documentation, the north and south sections of the 100-BC effluent pipeline are discussed separately in this section. The 100-BC north effluent pipelines were located north of B Avenue and consisted of four sections of pipeline (i.e., waste sites) including 100-B-8:2. The 100-BC south effluent pipelines were located south of B Avenue and consisted of two sections of pipeline including 100-B-8:1. Information provided below for the 100-BC north and 100-BC south effluent pipelines consist of both 100-B-8 and 100-C-6 waste sites. Only quantities and costs of the 100-BC north effluent pipelines (100-B-8:1 and 100-C-6:1) have been included in Section 8.0 of this report.

4.6.1 History of 100-BC Effluent Pipelines

The 100-BC effluent pipelines were underground pipelines. The pipelines were used in conjunction with the 105-B and 105-C nuclear reactor operations to transport radioactive effluent from the reactors. Cooling water passed through the reactor cores absorbed thermal energy from the nuclear process and became contaminated with radioactive activation and fission products. Effluent water passed from the 105-B and 105-C Reactor's rear face and flowed by gravity through the effluent pipelines, junction boxes, and diversion boxes to the 100-BC Area retention basins. The effluent water was held in retention basins for a short period of time to allow thermal and radiological cooling before being released through the 116-B-7, 132-B-6, and 132-C-2 Outfall structures to the Columbia River.

4.6.2 100-BC North Excavation Operations (100-B-8:2)

Remedial action at the 100-BC north pipelines site began on February 26, 2001. Excavation of the site involved removing the overburden materials, piping, debris, and underlying contaminated soil. Based on field screening, overburden materials identified as potentially clean were placed in stockpiles for potential use as backfill. Contaminated materials were disposed of at ERDF.

At the completion of remedial activities at the 100-BC pipeline waste sites, more than 364 metric tons (400 US tons) of concrete and fence posts with associated concrete debris were removed and segregated as part of the 100-BC Pipeline Remediation Project. External radiological surveys indicate that none of the concrete and fence posts show any signs of radioactive contamination. Radiological release surveys of the fence posts and concrete were performed to allow them to be used as clean backfill.

The excavation was completed on February 6, 2003. The elevation at the bottom of the excavation was approximately 135 m (441 ft) on completion. The excavation was approximately 135,000 m² (443,000 ft²) in area with a maximum depth of approximately 7.5 m (25 ft). Approximately 244,656 metric tons (269,742 US tons) of material including soil, debris, and piping were removed from the 100-BC north pipelines site and disposed of at ERDF.

4.6.3 100-BC North Verification Sampling (100-B-8:2)

Cleanup verification sampling began on August 12, 2002, and concluded July 24, 2003. Each verification sample was a composite formed by combining samples collected at four randomly selected nodes within each sampling area.

The 100-BC north pipeline site consisted of shallow zone and deep zone decision units. The site was excavated to a maximum depth of approximately 7.5 m (25 ft), with the shallow zone consisting of the excavation sidewalls to a depth of 4.6 m (15 ft) and the deep zone consisting of the excavation sidewalls below 4.6 m (15 ft) together with the floor of the excavation. All deep zone samples were collected below 4.6 m (15 ft).

Within the shallow zone of the 100-BC pipeline excavation, there were nine noncontiguous "islands" of excavation below 4.6 m (15 ft) (i.e., deep zone). Because of the potential for randomly selected sample locations to miss these small islands, a stratified sampling approach was implemented to ensure adequate sample coverage of the deep zone islands. The stratified approach required that in addition to the composite sample locations identified in the random phase 1 sample design, at least one biased sample node location was chosen within each of the deep zone islands. The biased sample results were included in determination of the 95% upper confidence limit statistical value for the deep zone. This stratified approach ensures proper sample coverage and satisfies EPA's request to bias sample distribution in small "islands" to ensure adequate coverage and representation, as documented in the 100 Area Unit Managers Meeting that was held on June 28, 2001 (EPA et al. 2001).

4.6.4 100-BC South Excavation Operations (100-B-8:1)

Remedial action at the 100-BC south pipelines site began on September 9, 2002. Excavation of the site involved removing the overburden materials, piping, debris, and underlying contaminated soil. Based on field screening, overburden materials identified as potentially clean were placed in stockpiles for potential use as backfill. Contaminated materials were disposed of at ERDF.

At the completion of remedial activities at the 100-BC pipeline waste sites, more than 364 metric tons (400 US tons) of concrete and fence posts with associated concrete debris were removed and segregated. Similar to 100-BC north, uncontaminated fence posts, fencing, and concrete with no indication of radioactive contamination were used for clean backfill.

The excavation was completed on November 7, 2003. The elevation at the bottom of the excavation was approximately 138 m (453 ft) on completion. The excavation was approximately 48,260 m² (519,466 ft²) in area with a maximum depth of approximately 8.5 m (28 ft). Approximately 79,339 metric tons (87,456 US tons) of material including soil, debris, and piping were removed from the 100-BC south pipelines site and taken to ERDF.

4.6.5 100-BC South Verification Sampling (100-B-8:1)

Final cleanup verification sampling began on October 24, 2003. Each verification sample was a composite formed by combining samples collected at four randomly selected nodes within each sampling area. The 100-BC south pipelines site consisted of shallow zone, deep zone, and overburden decision units. The site was excavated to a maximum depth of approximately 8.5 m (28 ft), with the shallow zone consisting of the excavation sidewalls to a depth of 4.6 m (15 ft) and the deep zone consisting of the excavation sidewalls below 4.6 m (15 ft) together with the floor of the excavation. All deep zone samples were collected below 4.6 m (15 ft).

4.6.6 Statement of Protectiveness

The verification sample results confirm that remedial action at the 100-BC north and south pipeline sites have achieved the RAOs and corresponding RAGs established in the approved interim actions ROD and have been reclassified in WIDS as "Interim Closed Out." The remaining soils at these sites have been sampled, analyzed, and evaluated. The results of this effort indicate that the materials from the 100-B-8:1 and 100-B-8:2 waste sites containing COCs at concentrations exceeding RAGs have been excavated and disposed of at ERDF. These results also indicate that residual concentrations in the shallow zone will support future land uses that can be represented (or bounded) by a rural-residential scenario, and that residual concentrations throughout the site pose no threat to groundwater or the Columbia River. The acceptability of unrestricted direct exposure to deep zone soils has not been demonstrated; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are required.

4.7 100-B-10, 107-B BASIN LEAK AND WARM SPRINGS

No cleanup was performed at the 100-B-10 waste site. The referenced spring no longer exists, and the precise location was not mentioned in historical documentation. In 1991, in preparation for a spring sampling study, the entire shoreline of the Columbia River in the 100 Areas was searched for springs. Three were located in the 100-BC Area; however, all were approximately 700 m (2,300 ft) upstream of the estimated location of the spring. No springs were located at or near the Columbia River.

This site did not consist of wastes that had been disposed or spilled, but rather was a location where groundwater contaminated from the 116-B-11 Retention Basin exited the riverbank. The 116-B-11 Retention Basin and underlying plumes from old spills have been remediated and interim closed out. The groundwater will be addressed under the 100-BC-5 OU, and this site was reclassified in April 2002 to "No Action."

4.8 100-B-11, 115-B/C CAISSON SITE, 115-B/C SUMP, 115-B/C DRYWELL**4.8.1 History**

The 100-B-11 waste site was a vertical steel pipe structure (caisson) about 1.2 m (4 ft) in diameter and approximately 1.7 m (5.5 ft) deep with a bottom and a steel plate placed over the top. The site was self-contained without any incoming or outgoing piping. Its original purpose was not known, and was identified during a pre-demolition walk-through of the 115-B/C Gas Recirculation Building and was removed during building demolition. The caisson contained sludge and water that was heavily contaminated with chromium, which was removed and disposed of during the demolition of the 115-B/C Building, along with contaminated soil.

4.8.2 Investigation

Confirmatory sampling was done at the location of the caisson at the 100-B-11 waste site in September 2003. One test pit was judgmentally located at the coordinates of the waste site, and soil samples were collected from four elevations. The maximum detected results from the four soil samples were used to support site reclassification.

4.8.3 Statement of Protectiveness

The confirmatory sampling results demonstrate that the 100-B-11 waste site meets the objectives for "No Action" as established in the interim action ROD and the site has been reclassified as "No Action." These results show that residual soil concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario. The results also demonstrate that residual contaminant concentrations support unrestricted future use of shallow zone soil and contaminant levels remaining in the soil are protective of groundwater and the Columbia River.

4.9 100-B-12, FILTER BOX RADIOLOGICAL MATERIALS AREA**4.9.1 History**

The 100-B-12 Filter Box Storage Area was a radiological materials area (RMA). The RMA was used to store metal boxes containing filters. Six out of the 10 metal boxes stored in the RMA were marked with posting indicating fixed contamination. Waste at this site was originally stored in 190-C or 183-C and was generated in the 100-N Area during the 1980s. The EPA requested that the RMA be entered into WIDS to document its existence and location.

4.9.2 Investigation

All contaminated filter frames have been disposed of at ERDF. Since the filter frames were solid waste, no releases to the soil were expected; therefore, no verification samples were required. After the filter frames were removed, a radiation survey was completed documenting that the RMA could be down-posted.

4.9.3 Statement of Protectiveness

The site was reclassified as "Interim Closed Out" and no institutional controls are required for this site to prevent uncontrolled drilling or excavation into deep zone.

4.10 100-B-14, 100-B AREA PROCESS AND SANITARY SEWER UNDERGROUND PIPELINES

4.10.1 History

The 100-B-14 waste site comprises the underground process pipelines and process and sanitary sewers associated with the 100-B Area pre-reactor cooling water treatment facilities. For confirmatory sampling efforts, the 100-B-14 waste site was administratively divided into seven subsites for decision-making purposes based on the use of the pipelines (e.g., sanitary versus process sewers), expected sources of contamination, potential differing remedial action determinations, and geographical location. Two additional subsites were subsequently created to encompass pipelines thought to have been excluded from the initial delineation, but which actually were included in the 100-B-14:2 subsite. These subsites were administratively cancelled to resolve the redundancy. The nine subsites, including those cancelled, are provided in Table 4-4.

Table 4-4. 100-B Process Sewer Pipeline Subsite Closure Summary.

Subsite	Site Name	Decision
100-B-14:1	Main Process Sewer Collection Line	RTD
100-B-14:2, Area 1	1607-B2 Sanitary Sewer (108-B Sanitary Lines)	RTD
100-B-14:2, Area 2	1607-B7 Sanitary Sewer	RTD
100-B-14:2, Area 3	1607-B2 Sanitary Sewer (1700-Series Building Lines)	No Action
100-B-14:2, Area 4	1607-B2 Sanitary Sewer (190-B Sanitary Lines)	RTD – miscommunicated to design
100-B-14:2, Area 5	1607-B2 Sanitary Sewer (115-B/C Sanitary Lines)	RTD
100-B-14:3	West Process Sewer Lines (182-B and 183-B)	No Action
100-B-14:4	105-B Cooling Water Pipe Tunnels	No Action
100-B-14:5	Sodium Dichromate and Sodium Silicate Lines	No Action
100-B-14:6	184-B Powerhouse Pipelines	No Action
100-B-14:7	185-B/190-B Sump and Pipelines	No Action
100-B-14:8	190-B Sanitary Sewer	Cancelled – redundant to 100-B-14:2, Area 4
100-B-14:9	1607-B7 Sanitary Sewer	Cancelled – redundant to 100-B-14:2, Area 2

RTD = remove, treat, dispose

4.10.2 No Action 100-B-14 Subsites

4.10.2.1 100-B-14:3 Investigation. Confirmatory sampling was conducted at the 100-B-14:3 subsite in October 2003. The sampling approach consisted of collecting three samples of pipe scale material from each of three manholes and one soil sample from below one manhole/pipe. The maximum detected results from the scale and soil samples were used to support waste site reclassification. In accordance with this evaluation, the confirmatory sampling results from scale and soil samples support a "No Action" reclassification of the 100-B-14:3 subsite.

4.10.2.2 100-B-14:4 Investigation. The 100-B-14:4 pipelines were removed and the tunnels collapsed in 1993 during deactivation and decommissioning of the 190-B Pumphouse. There is no history of radiological contamination associated with the 100-B Reactor cooling water tunnels and no radiological contamination was detected during decommissioning of the tunnels. There were no known process incidents at 105-B Reactor that would have introduced radiological contamination from the reactor into the tunnels. Additionally, since the 105-B cooling water tunnels had the same source of water as the 105-C cooling water tunnels, the 105-B tunnels are analogous to the 105-C tunnels. Historical sampling indicated that no unacceptable levels of residual hexavalent chromium exist in the 105-C tunnels. The 100-B-14:4 pipelines are removed and the remaining concrete at the site is analogous to concrete in the 105-C cooling water tunnels. The 105-C tunnels have been determined to meet the cleanup criteria; therefore, the 100-B-14:4 waste site also meets the cleanup criteria and the remaining contaminant levels are protective of groundwater and the Columbia River.

4.10.2.3 100-B-14:5 Investigation. Confirmatory sampling was conducted at the 100-B-14:5 subsite in October 2003. The original sampling approach consisted of collecting one sample of pipe scale and one soil sample from below each pipe at two sampling locations. Since no scale or sediment was found in the piping at the selected locations, two alternative soil locations along the piping were sampled. The maximum detected results from soil samples were used to support waste site reclassification. The results of the confirmatory sampling support a "No Action" reclassification of the 100-B-14:5 subsite.

4.10.2.4 100-B-14:6 Investigation. Confirmatory sampling was conducted at the 100-B-14:6 subsite in September and October 2003. The sampling approach consisted of collecting one sample of pipe-scale material from each of two manholes and one soil sample from below each manhole/pipe. The maximum detected results from the scale and soil samples were used to support waste site reclassification. The results of the confirmatory sampling support a "No Action" reclassification of the 100-B-14:6 subsite.

4.10.2.5 100-B-14:7 Investigation. Confirmatory sampling was conducted at the 100-B-14:7 waste site in October 2003. A focused sampling approach was selected for this site, biased toward worst-case sample locations and locations that were accessible. The sampling approach consisted of collecting a sample of the 61-cm (24-in.) pipe contents; a sample from the sump floor; and two soil samples, one below the pipe and one below the sump. During field excavation of the sump, an additional 46-cm (18-in.) line was found entering the sump, and

sediment from inside the pipe was also sampled. The maximum detected results from the scale and soil samples were used to support site reclassification. The "No Action" decision for the 100-B-14:7 waste site is supported based on reviews of site history, field observations, and sampling results.

4.10.3 Remedial Action 100-B-14 Subsites

4.10.3.1 100-B-14:1 Investigation and Excavation Operations. The 100-B-14:1 subsite was evaluated during October 2003 using confirmatory sampling efforts to determine whether remedial action would be required. Focused samples were collected from manholes, pipelines exposed by other remedial activities, and underlying soils. Multiple chemical and radiological contaminants were detected above action levels within the feeder pipelines, and remedial action was determined to be necessary for all of the pipelines.

Site remediation consisted of the removal of pipelines, as well as adjacent, potentially-contaminated soils for disposal at ERDF.

4.10.3.2 100-B-14:1 Verification Sampling. Cleanup verification sampling was initially conducted from May to June 2006. Following detection of elevated carbon-14 in overburden soils, portions of the stockpiled material were removed and additional sampling was performed in September 2006. Elevated carbon-14 was again detected in one field duplicate sample, but not in the associated primary sample. Based on this occurrence and the results of modified leachability tests on overburden soil samples with elevated carbon-14, residual carbon-14 was determined to be particulate (and thus relatively nonleachable) in nature. Accordingly, soil from the sampling area where elevated carbon-14 was detected in the field duplicate sample was used to backfill deep zone portions of the 100-B-14:1 excavation. The remaining results indicated that the waste removal action achieved compliance with the RAOs for the site.

4.10.3.3 100-B-14:2 Investigation and Excavation Operations. The 100-B-14:2 subsite was further divided into five service areas based on the facilities serviced, as identified in Table 4-4, and included the 1607-B2 waste site.

The sites were evaluated during September/October 2003 and June 2005 using confirmatory sampling efforts to make a decision whether remedial action would be required. Focused samples were collected from manholes, pipelines exposed by other remedial activities, and underlying soils. Multiple chemical and radiological contaminants were detected above action levels within the feeder pipelines, and remedial action was determined to be necessary for all of the pipelines, except the feeder lines formerly associated with the 1704-B, 1707-BA, 1713-B, 1717-B, 1719-B, and 1722-B Facilities (designated as area 3 of the 100-B-14:2 subsite).

Site remediation consisted of the removal of the sewer piping, septic tank, and drain field, as well as adjacent, potentially-contaminated soils for disposal at ERDF. Because chemical and radionuclide contaminants were detected within feeder pipelines, the site was remediated by removing piping, the septic system, and surrounding soils and transporting them to ERDF,

except at 100-B-14:2 (area 3), where confirmatory sampling did not demonstrate a need for remediation.

4.10.3.4 116-B-14:2 Verification Sampling. Following site remediation, verification sampling within the remediation footprints was conducted from August 2005 to July 2006. Statistical and judgmental sampling to verify the completeness of remediation was performed.

4.10.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 100-B-14:2 subsites have achieved the RAOs and corresponding RAGs established in the interim action ROD and have been reclassified as "Interim Closed Out." The results show that residual soil concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario. The results also demonstrate that residual contaminant concentrations support unrestricted future use and are protective of groundwater and the Columbia River. The 100-B-14:2 waste site does not have a deep zone component; therefore, no deep zone institutional controls are required. For 100-B-14:1, the acceptability of direct contact with residual deep zone contamination has not been demonstrated; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone of the subsite are required.

4.11 100-B-16, UTILITY POLES AND FIXTURES DEBRIS PILE

4.11.1 History

The 100-B-16 waste site consisted of four surface debris piles. The surface debris materials were composed of telephone poles (most of which were grouped together) and associated utility debris in piles adjacent to the telephone poles. Associated debris included unsheathed wire ropes, metal light poles, aluminum utility framing, rubber-insulated wires, ceramic insulators, broken light bulbs, light fixtures, lead bolts, and other wood pieces (including pressure-treated lumber).

4.11.2 Excavation Operations

Remedial action of the 100-B-16 waste site began in November 2004. All of the debris piles were removed and 639 bank cubic meters (BCM) of material was collected, sorted, and disposed of at ERDF. Because the verification sample results exceeded the asbestos criteria, an additional 135 BCM of soil was removed on March 7, 2005.

4.11.3 Verification Sampling

Cleanup verification sampling consisted of two sampling events. The initial verification sampling was conducted on January 25, 2005. A focused sampling approach was selected for the site, biased towards potential worst-case contaminant locations. Verification sampling was conducted in four sampling locations and focused on locations where soil staining or potential asbestos-containing material was observed after the debris piles had been removed. If visible

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staining was not evident, samples were collected from surface soils beneath the locations of the remediated debris piles where the highest potential for contaminant release could have occurred. One additional verification sample was collected on March 7, 2005, to address the additional asbestos remediation.

4.11.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 100-B-16 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." These results also show that residual soil concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario and that contaminant levels remaining in the soil are protective of groundwater and the Columbia River.

4.12 100-B-17, TRANSITE ON COLUMBIA RIVER SHORELINE AT 100 B

Located on the shoreline of the river just west of the 181-B Pumphouse, this dump site contained corrugated transite, fire brick, milk bottles, concrete form fittings, small rebar, pipe fittings, chunks of vitrified clay, nuts, and bolts. The material was removed and a visual examination confirmed that no CERCLA hazardous materials were present, resulting in its reclassification as "Rejected."

4.13 100-B-18, 184-B POWERHOUSE DEBRIS PILE

4.13.1 History

The 100-B-18 waste site was located approximately 450 m (1,500 ft) northwest of the former location of the 184-B Powerhouse. The 100-B-18 waste site was a debris pile containing miscellaneous demolition waste from decommissioning activities of the 184-B Powerhouse. The debris covered an area roughly 15 by 30 m (50 by 100 ft). Materials observed at the site included numerous concrete blocks, mixed aggregate/concrete slabs, stone rubble, asphalt rubble, rusted metal piping and plumbing, traces of tar/coal, paint, broken fluorescent lights, creosote timbers, brick chimney remnants, and rubber hoses. Nonfriable asbestos-containing material (ACM) was observed at the site and included fragments of corrugated ACM siding and remnants of an asbestos-cloth fire hose.

4.13.2 Excavation Operations

Remedial action at the 100-B-18 waste site began in June 2007 and consisted of the removal of suspect hazardous material identified at the surface of the site. Since the majority of the material disposed of at the site was inert material, remediation was accomplished by selective removal of suspect hazardous items (light ballasts, tar/mastic debris) and potentially impacted soils. A total of 70 BCM of tar/mastic material and surrounding soils was disposed at ERDF. In addition,

numerous intact and broken fluorescent light tubes located at the site were picked up and disposed. Other inert debris and material were left in place at the site.

4.13.3 Verification Sampling

Verification sampling at 100-B-18 waste site of the soils underlying the locations where the tar/mastic debris had been removed was performed on June 27, 2007. One focused sample was collected and analyzed for COPCs. In addition, 10 underlying verification samples were collected in July 2007 from the 10 former light tube locations.

4.13.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 100-B-18 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." These results show that residual soil concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario. The results also demonstrate that residual contaminant concentrations support unrestricted future use of shallow zone soil and that contaminant levels remaining in the soil are protective of groundwater and the Columbia River.

4.14 100-B-19, 100-BC STAINED SOIL SITES

4.14.1 History

The 100-B-19 waste site consisted of six stained soil areas, located throughout the 100-BC Area, that were discovered during field visits in 2004. The areas included three garnet sand areas and three sulfuric-acid stained-soil areas.

4.14.2 Excavation Operations

Remedial action at the 100-B-19 waste site was performed in two phases. The first phase was conducted from June through October 2007 and resulted in the removal of 11,390 metric tons (12,550 US tons) of material, which were disposed of at ERDF. Additional remediation conducted between February and July 2009 resulted in the removal of an additional 1,150 metric tons (1,270 US tons) at two of the locations.

4.14.3 Verification Sampling

Verification sampling for the 100-B-19 waste site was performed under two separate sampling instructions. After the initial remediation, verification soil samples were collected from all six stained soil locations in February and March 2008, of which two exceeded the RAGs. Verification samples from the second phase of the 100-B-19 waste site were collected in August 2009. Verification sampling consisted of both statistical and judgmental sampling. Statistical sampling designs were conducted using a random-start, triangular grid and were

composed of discrete grab samples. Judgmental composite samples were collected from various locations within a sample area selected at the judgment of the project analytical lead.

Judgmental samples were composed of 25 aliquots of soil that were combined and homogenized to obtain a single sample.

4.14.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 100-B-19 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." Residual soil concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario. The results also demonstrate that residual contaminant concentrations support unrestricted future use of shallow zone soil and contaminant levels remaining in the soil are protective of groundwater and the Columbia River.

4.15 100-B-20, 1716-B MAINTENANCE GARAGE UNDERGROUND TANK

4.15.1 History

The 100-B-20 waste site was located approximately 300 m (984 ft) northwest of the 105-B Reactor building on the south side of B Avenue. The waste site consisted of a 454-L (120-gal) oil underground storage tank (UST) that serviced the former 1716-B Maintenance Garage. The 1716-B Maintenance Garage was built in 1944 and provided automotive repair and light vehicle maintenance and lubrication service for the 100-BC Area vehicles until deactivation of the 105-B Reactor in 1968. In 1979, the equipment was excessed and the entire facility was removed. The gasoline UST that supported the garage was removed in 1992 and no residual contamination was identified in soil samples taken from beneath the tank. However, the oil UST was believed to have been abandoned in place.

4.15.2 Excavation Operations

A geophysical survey of the 100-B-20 waste site identified one anomalous area that was determined to be the most likely location for the UST and was chosen as the primary sampling location. A second area was also identified during the geophysical survey that contained subsurface anomalous material. This site was selected as a secondary sampling area if the UST was not located in the first area.

On January 18 and 19, 2006, a test trench was excavated in the first sample area. The UST was encountered within the excavation trench approximately 1.7 to 1.8 m (5.5 to 6 ft) below ground surface and consisted of two separate compartments, each of which contained waste material. The larger compartment had an approximate capacity of 946 to 1,136 L (250 to 300 gal) and contained 189 to 227 L (50 to 60 gal) of sludge. The smaller compartment had an approximate capacity of 379 to 568 L (100 to 150 gal) and contained 19 to 38 L (5 to 10 gal) of a soil/water/diesel mixture.

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The UST and contents were placed into a B-25 box pending disposal. In addition, approximately 0.3 m (1 ft) of soil was excavated from the location underlying the UST and placed into a second B-25 box. The contents of the B-25 boxes were managed and disposed of separately in accordance with WAC 173-303, "Dangerous Waste Regulations," and the waste was disposed of at ERDF.

4.15.3 Investigation

Confirmatory sampling at the 100-B-20 waste site was performed and consisted of three samples from the UST site excavation. The excavation was backfilled with clean soil upon completion of confirmatory sampling. According to the sample design, the excavation in the second sample area was to occur only if the tank was not located in the first sample area. Although the UST had been discovered in the first area, a decision was made to excavate a test pit in the second sample area. During the excavation, stained soil was encountered approximately 1.2 to 1.4 m (4 to 4.5 ft) below ground surface. A sample of the stained, reddish-yellowish brown silty soil was collected and submitted for analysis. The origin of the stained soil is unknown, however, the stained soil was removed and the site backfilled with clean soil at the end of confirmatory sampling. The depth of excavation for the 100-B-20 waste site was 2.1 m (6.9 ft).

4.15.4 Statement of Protectiveness

The confirmatory sampling results demonstrate that remedial actions at the 100-B-20 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." These results show that residual soil concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario. The results also demonstrate that residual contaminant concentrations support unrestricted future use of shallow zone soil and that contaminant levels remaining in the soil are protective of groundwater and the Columbia River.

4.16 100-B-21, 100-BC MISCELLANEOUS PIPELINES

4.16.1 History

The 100-B-21 miscellaneous pipelines were uncovered during remediation of the 100-BC Reactor effluent pipelines and soils. The pipelines were separated into four subsites based on physical location and designated 100-B-21:1 through 100-B-21:4.

4.16.2 Investigation

An evaluation of the 100-B-21:1 pipelines using site histories and process knowledge, analytical data, and field observation supports the reclassification as "No Action." The evaluation has found this subsite to meet the cleanup objectives for direct exposure, groundwater protection, and river protection. The remaining three subsites were determined to require remediation.

4.16.3 Excavation Operations

Subsites 100-B-21:2 through 100-B-21:4 were remediated between June 2007 and April 2009. This included the pipeline segments and any associated surrounding soil. A total of 942 metric tons (1,043 US tons) were excavated and disposed at ERDF.

Remediation of the 100-B-21:2 waste site was performed from June 11 through June 18, 2007. The pipeline, soil in contact with the pipe, and soil 0.3 m (1 ft) below the pipeline were removed. Approximately 91 metric tons (100 US tons) of material were removed and disposed of at ERDF.

Remediation of the 100-B-21:3 waste site was performed from June 2007 through January 2008. The pipeline, soil in contact with the pipe, and soil 0.3 m (1 ft) below the pipeline were removed. Approximately 850 metric tons (940 US tons) of material were removed and disposed of at ERDF.

Remediation of the 100-B-21:4 waste site was performed between April 13 and April 29, 2009. Approximately 400 BCM (523 bank cubic yards [BCY]) of debris and associated soils were removed and disposed of at ERDF.

4.16.4 Verification Sampling

Cleanup verification sampling at the 100-B-21:2 and 100-B-21:3 subsites consisted of 10 soil samples at each site that were collected on a triangular grid using a random-start systematic grid.

Cleanup verification sampling at the 100-B-21:4 subsite consisted of 12 statistical soil samples that were collected from a narrow segment of the excavation floor directly below the remediated pipeline. The excavation floor is at a depth of 7.5 m (25 ft) below ground surface, and the vadose beneath the excavation is greater than 25 m (83 ft) thick. The sampled area contained the base of the pipeline excavation, with the addition of 2 m (6 ft) to the north of the pipeline and 0.3 m (1 ft) to the south of the pipeline.

4.16.5 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the three 100-B-21 subsites have achieved the RAOs and corresponding RAGs established in the interim action ROD and have been reclassified as "Interim Closed Out." The results show that residual soil concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario. The results also demonstrate that residual contaminant concentrations support unrestricted future use and are protective of groundwater and the Columbia River. Subsites 100-B-21:2 and 100-B-21:3 do not have a deep zone or residual-contaminant concentrations that would require any institutional controls. For 100-B-21:4, the acceptability of direct contact with residual deep zone contamination has not been demonstrated; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone of the subsite are required.

4.17 100-B-22, 100-B WATER TREATMENT FACILITIES AND SURROUNDING SOILS

4.17.1 History

The 100-B-22 waste site consisted of several water treatment facilities, interconnecting piping, and surrounding soils associated with the 100-B Area. To aid in the final closeout, the site was divided into two subsites that included the interconnecting pipelines and associated soils (100-B-22:1), and the buildings and associated soils (100-B-22:2). The 100-B-22:1 subsite included the major piping between these facilities, as well as the 183-B Clearwells (addressed separately as the 126-B-2 waste site). The 100-B-22:2 subsite included the 183-B Filter Plant, the 185-B Deaeration Plant, and the 190-B Process Pump house footprints.

4.17.2 Investigation

An examination of strategically excavated trenches, as well as historical documents and drawings, found that all of the 100-B-22:1 pipelines are more than 0.15 m (6 in.) in diameter and were used for raw water, process water (prior to the addition of sodium dichromate), fire suppression water, and sanitary water. None of the 100-B-22:1 pipelines carried environmentally significant contamination, which resulted in the reclassification of "No Action."

For the 100-B-22:2 waste site, confirmatory sampling was performed in 2007 and 2009 to make a decision whether remedial action would be required. The entry points for process chemicals into the former facilities were targeted for visual investigation and focused sampling.

4.17.3 Excavation Operations

Based on the results of the 100-B-22:2 confirmatory sampling, it was determined that remediation was required only for a small drain line associated with the 183-B Headhouse. Remediation was performed in May 2009 by excavating approximately 40 m³ (50 yd³) of pipe debris and soil and disposing it at ERDF.

4.17.4 Verification Sampling

Cleanup verification sampling was conducted in September 2009. The footprint area associated with the remediation of the headhouse drain line was small and had discrete worst-case locations for potential contamination. Therefore, a focused sampling approach was employed, with samples collected from within the excavation at four locations: (1) directly beneath the former surface drain, (2) from stained soils on the southern side of the concrete footing, (3) beneath the former pipeline near the concrete pad foundation at the base of the concrete footing, and (4) from visibly stained soils at the southeastern corner of the excavation.

4.17.5 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 100-B-22:2 subsite have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." These results show that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils. The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. This site does not have residual contaminant concentrations that would require any deep zone institutional controls.

4.18 100-B-24, 1904-B2 SPILLWAY

4.18.1 History

The 100-B-24 Spillway was located northwest of 116-B-11 (107-B Retention Basin) and is associated with the 116-B-7 Outfall structure. The spillway was an open, three-sided trough, with 30-cm (12-in.) thick walls. At the discharge end is an engineered erosion barrier of heavy riprap. Originally, the spillway extended from the outfall to the river shoreline. There is no physical or historical evidence that the spillway was ever used.

4.18.2 Investigation

Confirmatory sampling of the site was conducted on January 17, 2006. Soil covering the concrete spillway floor was excavated and samples of the concrete were collected by scabbling. The sample results indicated antimony, arsenic, barium, copper, lead, and zinc exceeded RAGs for soils. Concentrations of antimony, barium, and lead were within the range of Hanford Site background levels. There are no known health or ecological effects due to metals and/or arsenic bound in concrete. Because the contaminants are bound within the concrete of the 100-B-24 spillway, the waste site achieves compliance with the RAOs.

4.18.3 Statement of Protectiveness

In accordance with this evaluation, the confirmatory sampling results support a reclassification of this site to "No Action." These results show that residual concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario. The results also demonstrate that residual contaminant concentrations support unrestricted future use of shallow zone soil and that residual-contaminant levels are protective of groundwater and the Columbia River. Because the contaminants are bound in concrete and are not readily available to ecological receptors, protection of the environment is also achieved.

4.19 10-B-25, 1902-B SPILLWAY**4.19.1 History**

The 1902-B Spillway was located north of 116-B-11 (the 107-B Retention Basin) and was associated with 132-B-6 Outfall structure. The spillway was an open, three-sided trough with 30-cm (12-in.) thick walls. At the discharge end was an engineered erosion barrier consisting of heavy riprap that was approximately 9 by 9 m (30 by 30 ft). Originally, the spillway extended from the outfall to the low water level on the river shoreline. The upper portion of the spillway was removed during the remediation of the 132-B-6 Outfall structure in 2001. The riprap showed elevated gamma radiation readings during a 2002 survey, prompting a decision to remediate the remaining portion of the spillway and the riprap.

4.19.2 Excavation Operations

Remedial action at the 100-B-25 waste site was performed between February 3 and March 14, 2009. Remediation encompassed the removal of a large volume of overburden that had been added in 2001, after the upper portion of the spillway was removed. The remaining spillway structure was unearthed and removed, and the basalt rocks riprap that showed elevated radiation readings was also removed. The site was excavated to a maximum depth of approximately 5 m (16 ft) below grade, resulting in the removal of approximately 2,682 m³ (3,504 yd³) of material for disposal at ERDF.

4.19.3 Verification Sampling

Verification sampling was performed from July to September 2009. The 100-B-25 waste site was divided into three decision units for the purpose of verification sampling. The first decision unit consisted of the excavation footprint, the second decision unit consisted of the overburden soil stockpile, and the third decision unit consisted of the staging pile footprints.

4.19.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 100-B-25 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." The residual soil concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario. The results also demonstrate that residual contaminant concentrations support unrestricted future use of shallow zone soil, and that contaminant levels remaining in the soil are protective of groundwater and the Columbia River. Site contamination extended slightly into the deep zone soils; however, the remediation footprint was evaluated against the more restrictive shallow zone criteria. Therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

4.20 100-B-26, 1904-C SPILLWAY**4.20.1 History**

The 100-B-26 Spillway was located north of 116-B-11 (the 107-B Retention Basin) and is associated with 132-C-2 Outfall structure. The spillway was an open, three-sided trough with 30-cm (12-in.) thick walls. At the discharge end was an engineered erosion barrier consisting of heavy riprap that is approximately 9 by 9 m (30 by 30 ft). Originally, the spillway extended from the outfall to the river shoreline.

As a part of cleanup effort in 1979, designated for facilities free of radiological contamination, the spillway walls were collapsed and the structure was covered with clean soil. The upper portion of the spillway was removed in 2001 as part of remediation of the 132-C-2 Outfall structure and the remainder of the spillway was backfilled with clean soil. The top part of the remaining structure was concrete and the bottom half was basalt riprap.

4.20.2 Investigation

Confirmatory sampling of the 100-B-26 waste site was conducted on January 17, 2006. Heavy equipment was used to excavate through the riprap, and the underlying soils were sampled. Sample results indicate that six constituents slightly exceed RAGs for the protection of groundwater and the Columbia River. The residual contaminants within the spillway present little risk to human health and/or the environment because metals will not leach out of concrete in significant concentrations.

4.20.3 Statement of Protectiveness

This evaluation confirms that the 100-B-26 waste site meets the requirements for reclassification as "No Action." The confirmatory sampling results show that contaminant levels remaining in the soil are more protective of groundwater and the Columbia River than the mobilization of contaminants that are possible during remediation of the site.

4.21 100-B-27, SODIUM DICHROMATE SPILL**4.21.1 History**

The 100-B-27 waste site was located immediately west of the former 126-B-3 coal pit dumping area and south of the northern 100-BC rail spur. This sodium dichromate spill was discovered during remediation of the 126-B-3 waste site. Soil contamination associated with the spill consisted of a fairly narrow, near-vertical plume of hexavalent chromium in the upper vadose zone (to approximately 11 m [36 ft] below ground level). Below this depth, the plume continued downward in a generally northeasterly direction; soil contamination was found down to the groundwater table, located approximately 13.5 m (44 ft) below grade.

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4.21.2 Excavation Operations

Initial remediation was performed at the 100-B-27 waste site from June 18, 2007, to June 20, 2007, to a depth of approximately 4.6 m (15 ft) below grade and resulted in the removal of approximately 900 metric tons (1,000 US tons) of contaminated material. Contamination above RAGs was observed at the bottom of the excavation. A pothole was excavated to approximately 10.7 m (35 ft) below grade and samples were collected to evaluate the vertical distribution of remaining contamination. These results indicated hexavalent chromium contamination above RAGs deeper than 10.7 m (35 ft) below grade, and a decision was made to temporarily backfill with clean borrow material.

Remediation resumed on February 26, 2009, and continued to the groundwater table, encountered at approximately 14 m (46 ft) below grade. Excavation activities were completed on June 9, 2009. Contaminated soil was disposed at ERDF. In total for all site remediation activities, approximately 10,190 m³ (13,330 yd³) of contaminated soil and 40,180 m³ (52,550 yd³) of overburden/layback soil were excavated at the 100-B-27 waste site.

4.21.3 Verification Sampling

Verification sampling was initiated on August 3, 2009, and completed on August 10, 2009. The 100-B-27 waste site was divided into three decision units for verification sampling. Decision Unit 1 is the excavated area, Decision Unit 2 is the overburden stockpiles, and Decision Unit 3 is the waste staging area footprints. The COPCs for the 100-B-27 waste site were determined based on available process information and field observations during remediation. The primary contamination at this site was related to sodium dichromate; therefore, the COPCs were hexavalent chromium and total chromium. Although not considered COPCs, analyses for the constituents of the expanded inductively-coupled plasma metals list was also performed.

4.21.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 100-B-27 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." These results also show that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils. The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. Site contamination that extended into the deep zone soils was completely removed; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

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4.22 100-B-28, 183-C HEADHOUSE TO 183-B PUMPHOUSE SODIUM DICHROMATE TRANSFER PIPELINE

4.22.1 History

The 100-B-28 waste site was an underground pipeline located between the 183-C Headhouse and the 183-B Filter Plant/Pumphouse. The pipeline was originally used to supply soft water from the 184-B Power House to the 183-C Headhouse. In 1962, the pipeline was modified to transfer sodium dichromate from the 183-C Headhouse to the 183-B Filter Plant. The northern end of the waste site was located approximately 430 m (1,410 ft) directly west of the 105-B Reactor, and the southern end of the pipeline was 9 m (28 ft) northwest of the former 183-C Filter Plant.

4.22.2 Excavation Operations

Remedial action at the 100-B-28 waste site was performed from February to April 2009. Remediation included removing and staging overburden material; hot tapping, draining, and collecting the pipeline liquid; size-reducing and removing the pipeline; and removing and staging contaminated material. A total of 397 m³ (519 yd³) of contaminated material was disposed to the ERDF. In addition, a french drain that was encountered in the northern section of the excavation was removed.

Two sections of the pipeline could not be removed due to the presence of active overlying utilities. They were subsequently filled with grout and administratively transferred to a new waste site created to collect components from various waste sites that cannot be remediated while utilities remain active.

4.22.3 Verification Sampling

The 100-B-28 waste site was divided into seven decision units for verification sampling. Verification sampling for the 100-B-28 waste site was performed between August 24 and August 26, 2009. The primary contamination at this site was related to sodium dichromate; therefore, the COPCs were hexavalent chromium and total chromium. Although not considered COPCs, analyses for the constituents of the expanded ICP metals list were also performed.

4.22.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 100-B-28 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." The results of verification sampling show that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils. The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River.

4.23 100-B-29, PIPE LOCATED SOUTHEAST OF 183-B CLEARWELLS

The site consisted of an abandoned, partially visible, 15-cm (6-in.) diameter by 50-m (164-ft) long underground carbon-steel pipe located southeast of the 183-B Clearwells. The results of a geophysical evaluation and review of aerial imagery led to the conclusion the pipe was likely a remnant from construction or modification of a water or steam system. Therefore, the site was classified as "Not Accepted."

4.24 100-B-32, SOIL CONTAMINATION AREA ASSOCIATED WITH LEGACY WASTE**4.24.1 History**

The 100-B-32 waste site was located south of the 182-B Reservoir just west of the intersection of Burnett Avenue and Bow Street, on the southern portion of the roadway surface. The waste site was created after down-posting surveys along the former haul route between the 118-B-1 Burial Ground and the container transfer area identified contamination matrixed in the roadway asphalt. This hot spot covered an area of approximately 25 cm² (3.8 in.²); radiological measurements at the surface detected approximately 3.4 million dpm/100 cm² beta/gamma activity and no detectable alpha activity.

4.24.2 Excavation Operations

Remedial action activities were performed on July 28, 2009, using an excavator to remove asphalt and underlying contaminated material identified by hand-held instrumentation. The contaminated material was loaded directly into a container for disposal at ERDF.

4.24.3 Verification Sampling

Verification sampling at the 100-B-32 waste site occurred on August 10, 2009. The COPCs were identified as beta/gamma-emitters based on detections with field instrumentation. Gamma energy analysis was performed to quantitate the major gamma-emitting radionuclides; gross alpha and gross beta analyses were also performed to assess the need for additional isotope-specific analyses. The measured gross alpha and beta activities were consistent with background; therefore, no further analyses were required.

4.24.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 100-B-32 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." The results of verification sampling show that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils. The results also demonstrate that residual contaminant concentrations are protective of groundwater and

the Columbia River. Site contamination did not extend into the deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

4.25 100-B-33, SOIL CONTAMINATION AREA 2 ASSOCIATED WITH LEGACY WASTE

4.25.1 History

The 100-B-33 waste site was discovered during a Global Positioning Radiological Surveyor survey of the northeast quadrant of the 100-BC Area in July and August 2007. The readings showed a 150-m² (1,600-ft²) area with radiological measurements averaging 15,000 counts per minute (cpm) and a maximum reading of 93,000 cpm. The source of this contamination is unknown; however, the proximity of the site to the 116-C-5 Retention Basin suggests that the contamination may be related to historic releases associated with this basin.

4.25.2 Excavation Operations

Remedial action at the 100-B-33 waste site was performed from May to August 2009. Remediation consisted of removing soils with elevated radiological activity identified with field instrumentation. In total, approximately 310 m³ (410 yd³) of contaminated soil was excavated and staged on site before being disposed at ERDF.

4.25.3 Verification Sampling

Verification sampling at the 100-B-33 waste site was conducted on September 2, 2009, to support a determination that residual contaminant concentrations at this site meet the cleanup criteria. The COPCs for the waste site were determined using historical sampling data from adjacent structures (e.g., 116-C-5 Retention Basin) and the results of characterization sampling. Professional judgment, field observations, and radiological survey information were used in the verification sampling design. Four samples were collected from the excavated area of the 100-B-33 waste site. Each sample consisted of 15 aliquots of soil distributed across the surface of the quadrant in the excavated area and combined into one sample.

4.25.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 100-B-33 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." These results show that residual soil concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario. The results also demonstrate that residual contaminant concentrations support unrestricted future use of shallow zone soil, and that contaminant levels remaining in the soil are protective of groundwater and the Columbia River.

4.26 116-B-1, 107-B LIQUID WASTE DISPOSAL TRENCH

4.26.1 History

The 116-B-1 waste site was an inactive liquid waste site that operated from 1946 to 1955. The trench was located 122 m (400 ft) east of the 116-B-11 Retention Basin and approximately 152 m (499 ft) from the 100-year flood level of the Columbia River. Historical documents describe the trench as an unlined french drain that was partly or completely filled with coarse gravel. The trench was approximately 61 m (200 ft) in length, 9.1 m (30 ft) wide, and 4.6 m (15 ft) deep. It received an estimated 60 million L (16 million gal) of effluent. The effluent was highly contaminated cooling water produced by the failure of fuel element cladding and diverted from the 116-B-11 Retention Basin. The fission products of 54 fuel ruptures were routed to this site.

A geophysical investigation performed in November and December 1996 showed the trench was almost twice as long as indicated in historical documents (113 by 15 by 4.6 m [371 by 49 by 15 ft]). A ground-penetrating radar survey identified a pipeline (labeled #10 in the survey report) entering the trench at its southwest end. No other pipelines were evident. A significant amount of subsurface debris was present in the northeastern half of the trench. WIDS also indicated that the site was covered to grade with clean fill. A significant amount of clean fill material remained at the site and extended 1.2 to 1.8 m (4 to 6 ft) above the surrounding grade. Sampling indicated that this fill material may have been the material originally excavated from the trench.

4.26.2 Excavation Operations

Excavation of the 116-B-1 waste site began on October 6, 1998, by removing the overburden materials and underlying contaminated soil. Based on field screening, clean overburden materials were placed in stockpiles for use as backfill. Overburden materials that were found to be contaminated were disposed of at ERDF. On January 6, 1999, the excavation had reached the design limit elevation of 128.0 m (438 ft). At the completion of the remedial action and removal of the engineered structure, the excavation area floor was approximately 1,863 m² (20,056 ft²) at a depth of approximately 4.6 m (15 ft). Approximately 43,033 metric tons (47,436 US tons) of material from the site were disposed of at ERDF.

4.26.3 Verification Sampling

Cleanup verification sampling began on February 1, 1999, and was finished on February 24, 1999. A total of eight shallow zone verification samples and six deep zone verification samples were collected. Each verification sample was a composite formed by combining samples collected at four randomly selected nodes within each sampling area. Verification sampling of 116-B-1 was conducted in shallow zone, deep zone, and overburden decision units. The site was excavated to a maximum depth of approximately 4.6 m (15 ft), with the shallow zone consisting of the entire excavation sidewalls to the final depth of 4.6 m (15 ft). The deep zone consisted of the excavation floor, 4.6 m (15 ft) below surface grade.

4.26.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 116-B-1 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." Materials that contain COCs at concentrations that exceed the RAGs have been excavated, sampled, analyzed, and shipped to ERDF. The remaining soil has been sampled, analyzed, and evaluated to show that no residual COC concentrations in vadose zone soils pose a threat to human health, groundwater, or the Columbia River. The acceptability of unrestricted direct exposure to deep zone soils has not been demonstrated; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are required

4.27 116-B-2, 105-B STORAGE BASIN TRENCH

4.27.1 History

The 116-B-2 Storage Basin Trench was located near the center of the 100-B Area and was approximately 865 m (2,838 ft) from the Columbia River. This inactive trench was 22.9 m (75 ft) long, 3.0 m (10 ft) wide, and 4.6 m (15 ft) deep and was used to manage low-level liquid waste.

The trench was used once in 1946 to receive contaminated basin water after a fuel element accident in the 105-B Storage Basin. A total of 4×10^6 L of liquid waste was discharge to the trench. Four soil samples collected indicate the contaminated soil volume at this site was estimated to be $1,700 \text{ m}^3$ ($6.0 \times 10^4 \text{ ft}^3$) (UNI 1978).

4.27.2 Excavation Operations

Excavation of the 116-B-2 waste site began on February 17, 1999, by removing the overburden materials and underlying contaminated soil. Based on field screening, overburden materials that were identified as potentially clean were placed in stockpiles for potential use as backfill. Overburden materials that were found to be contaminated were disposed of at ERDF. After completion of the initial excavation, several contaminated areas (i.e., plumes) were discovered. Each of the plumes was excavated and the new surfaces were screened for contamination. The excavation was completed on May 20, 1999, and 9,393 metric tons (10,354 US tons) of material from the site were disposed of at ERDF. The site was excavated to a maximum depth of approximately 4.9 m (16 ft).

4.27.3 Verification Samples

Verification sampling began on May 18, 1999, and was finished on June 24, 1999. Each verification sample was a composite formed by combining samples collected at four randomly selected nodes within each sampling area. Verification sampling of the 116-B-2 Fuel Storage Basin Trench was conducted in shallow zone and deep zone decision units with the shallow zone

consisting of the entire excavation sidewalls to the final depth of 4.9 m (16 ft). The deep zone consisted of the excavation floor, 4.9 m (16 ft) below surface grade.

4.27.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 116-B-2 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." Materials that contain COCs at concentrations exceeding the RAGs have been excavated and disposed of at ERDF. The remaining soils have been sampled, analyzed, and evaluated to show that residual concentrations will support future land uses that can be represented (or bounded) by a rural-residential scenario. The acceptability of unrestricted direct exposure to deep zone soils has not been demonstrated; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are required. The verification package also demonstrates that residual COC concentrations pose no threat to groundwater or the Columbia River.

4.28 116-B-3, 105-B PLUTO CRIB

4.28.1 History

The 116-B-3 Crib was an inactive liquid waste site that operated from 1951 to 1952. The crib was a 3-m (10-ft) long, 3-m (10-ft) wide, and 3-m (10-ft) deep wood vault located 30.5 m (100 ft) east of the 105-B Reactor building. During operations, the crib received 105-B Reactor cooling water. The crib was buried so that its upper surface was approximately at grade. Effluent entered the crib through a hatch on the upper surface of the crib. The effluent was contaminated by cladding ruptures of fuel elements.

4.28.2 Excavation Operations

Excavation of the 116-B-3 waste site began on February 17, 1999, by removing the overburden materials and underlying contaminated soil. Based on field screening data, clean overburden materials were placed in stockpiles for use as backfill. Contaminated overburden was disposed of at ERDF. The excavation was completed on March 11, 1999, and the area of the excavation was approximately 112 m² (1,210 ft²) at a maximum depth of approximately 4.6 m (15 ft). Approximately 244 metric tons (269 US tons) of material from the site were disposed of at ERDF.

4.28.3 Verification Samples

Verification sampling began on April 13, 1999, and was finished on May 12, 1999. Each verification sample was a composite formed by combining samples collected at four randomly selected nodes within each sampling area. Verification sampling of the 116-B-3 Pluto Crib was conducted in shallow zone and deep zone decision units. The shallow zone consisted of the entire excavation sidewalls to the final depth of 4.9 m (15 ft). The base of the excavation was considered the deep zone.

4.28.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 116-B-3 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." Materials that contain COCs at concentrations exceeding the RAGs have been excavated and disposed of at ERDF. The remaining soils have been sampled, analyzed, and evaluated to show that residual concentrations will support future land uses that can be represented (or bounded) by a rural-residential scenario. The acceptability of unrestricted direct exposure to deep zone soils has not been demonstrated; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are required. The results also demonstrate that residual COC concentrations pose no threat to groundwater or the Columbia River.

4.29 116-B-4, 105-B DUMMY DECONTAMINATION FRENCH DRAIN

4.29.1 History

The 116-B-4 French Drain was an inactive liquid waste site that operated from 1957 to 1968. The site received 3×10^5 L of neutralized acid rinse water from the 105-B Dummy Decontamination Facility. The drain was 1.2 m (4 ft) in diameter by 6 m (20 ft) deep and received the rinse water through a single, underground stainless steel pipe.

4.29.2 Excavation Operations

Remediation of 116-B-4 began on July 11, 1995. Excavation of the initial waste site footprint was completed July 28, 1995. Additional contaminated material was identified and partial excavation of the plumes began on September 25, 1995, and completed on December 18, 1995. Further excavation to complete the remediation of the 116-B-4 waste site plumes began on February 17, 1999, by removing the overburden materials and underlying contaminated soil. Based on field screening, materials identified as potentially clean were placed in stockpiles for potential use as backfill. Materials that were found to be contaminated were disposed of at ERDF. The excavation was completed on March 4, 1999, and the excavation floor area, excluding the 600 m^2 ($6,458 \text{ ft}^2$) 116-B-4 main site, was approximately $1,062 \text{ m}^2$ ($11,433 \text{ ft}^2$) at a depth of approximately 4.6 m (15 ft). Approximately 8,700 metric tons (9,590 US tons) of material from the site had been disposed of at ERDF.

4.29.3 Verification Samples

Initial sampling at the 116-B-4 was performed in 1995 and 1996 to support the 100-BC Demonstration Project. Verification sampling was performed after the final excavation of the site in 1999. Verification sampling began on April 12, 1999, and was completed on May 6, 1999, and consisted of both shallow and deep zone sampling. Each verification sample was a composite formed by combining samples collected at four randomly selected nodes within

each sampling area. The shallow zone was divided into four sampling areas while the deep zone was divided into three sampling areas.

4.29.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 116-B-4 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." Materials that contain COCs at concentrations exceeding the RAGs have been excavated and disposed of at ERDF. The remaining soils have been sampled, analyzed, and evaluated to show that residual concentrations will support future land uses that can be represented (or bounded) by a rural-residential scenario. The acceptability of unrestricted, direct exposure to deep zone soils has not been demonstrated; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are required. The results also demonstrate that residual COC concentrations pose no threat to groundwater or the Columbia River.

4.30 116-B-5 CRIB

4.30.1 History

The 116-B-5 Crib received wastes generated from the 108-B Building P-10 Project. This project performed tritium (H-3) separations to derive product for the U.S. Nuclear Weapons Program. The crib consisted of 12 rectangular cells approximately 2.4 m (8 ft) long and 2.4 m (8 ft) wide and 2.7 m (8.8 ft) deep. The crib was constructed of concrete members supporting a concrete roof. The crib had no structural bottom and was filled with sandy gravel and ash approximately 1.5 m (4.9 ft) thick. A single clay inlet pipe was encountered.

4.30.2 Excavation Operations

Remedial action at the 116-B-5 waste site began on June 26, 1995. Remediation of the site involved removing of overburden material consisting of fly-ash material and a concrete roof of the crib. The excavation continued until the entire crib structure was removed. The final excavation bottom dimensions measured approximately 34 by 8 by 5 m (111.5 by 26 by 16 ft) deep. Approximately 111 metric tons (122 US tons) of material was removed and disposed of at ERDF.

4.30.3 Verification Sampling

Initial sampling of the overburden began at a rate of one sample per 153 m³ (5,403 ft³) and was analyzed for radionuclides, mercury, barium and semivolatile organics. After overburden removal, the concrete crib lids were removed from each of the 12 cells. Analytical samples from the first lift were then taken from the center of the cell, approximately 1.8 m (6 ft) deep below surface. After a review of the initial analytical results from each cell, which revealed no contaminants above cleanup criteria, it was determined by the Tri-Parties to sample only selected

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cells at approximately 0.7 m (2.3 ft) lifts. Emphasis was placed on cells at the head end of the crib where contaminants were most likely to be found. Final sampling and analysis indicated only isolated cases of tritium concentrations above RAGs in two adjacent crib cells.

4.30.4 Statement of Protectiveness

The verification sampling results demonstrate the RAGs for direct exposure, WAC 173-340, "Model Toxics Control Act" (MTCA) level B cleanup standards, groundwater protection, and surface water protection (protection of the Columbia River) have all been achieved and has been reclassified as "Interim Closed Out." Materials contributing to the potential degradation of groundwater and the Columbia River have all been sampled, analyzed, and modeled to show that no remaining constituents pose an unacceptable threat to groundwater or the Columbia River.

4.31 116-B-6A, 111-B CRIB NO. 1, AND 116-B-16, 111-B FUEL EXAMINATION TANK

4.31.1 History

Located proximally and because COCs were similar, the 116-B-6A Crib and the 116-B-16 Fuel Examination Tank were remediated and interim-closed out together.

The 116-B-6A Crib was a liquid waste disposal site located immediately north of the former site of the 111-B Building. The crib received radioactive liquid wastes from equipment decontamination performed in the 111-B Building and fuel element spacers. The crib was approximately 3.7 m (12 ft) long and 2.4 m (8 ft) wide and up to 4.6 m (15 ft) deep. In April 1990, in situ vitrification traceability testing was performed at the crib. In situ vitrification is a thermal treatment process that converts contaminated soil into a chemically inert and stable glass and crystalline product. In situ vitrification impacted an area 4.3 m (14 ft) below grade and produced a block of vitrified material between 10.7 m (35 ft) and 12.2 m (40 ft) in diameter, approximately 3.8 (12 ft) high, and weighing between 726 metric tons (800 US tons) and 816 metric tons (900 US tons). All vitrified material was removed during remediation of the 116-B-6A/116-B-16 waste site and was disposed of at ERDF.

The 116-B-16 Fuel Examination Tank was a low-level liquid waste disposal site that was operational during the lifetime of the 111-B Metallurgical Examination Building. Located approximately 175 m (575 ft) southeast of the 105-B Reactor building, the tank received liquid wastes from the decontamination of fuel element spacers and other equipment as well as from other 111-B Building activities. The tank was constructed of concrete 3.3 m (10.7 ft) long, 1.8 m (5.8 ft) wide, and 2.7 m (9 ft) deep.

4.31.2 Excavation Operations

Excavation of the 116-B-6A/116-B-16 waste site involved removing the overburden materials, the contaminated structure, and underlying contaminated soil. Based on field screening,

overburden materials identified as potentially clean were placed in stockpiles for potential use as backfill. Materials shown to be contaminated were disposed of at ERDF. The excavation was completed on May 12, 1999, at an elevation of 141.4 m (464 ft). At completion of remedial action, the excavation area was approximately 603.5 m² (6,496 ft²) at a depth of 4.6 m (15 ft). Approximately 5,072 metric tons (5,591 US tons) of material from the site were disposed of at ERDF.

4.31.3 Verification Sampling

Cleanup verification sampling consisted of composite samples formed by combining samples collected at four randomly selected nodes within each sampling area. Cesium-137 (37.1 pCi/g) was detected in a composite soil sample. Subsequent field screening and laboratory analysis did not detect significant cesium-137 in discrete samples. Per agreement with EPA, the discrete sample results were averaged to simulate a field composite. These new values were then used in the cleanup verification calculations. The original elevated result could have been attributed to a small "speck" of contamination.

4.31.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 116-B-6A/116-B-16 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." Materials that contain COCs at concentrations exceeding the RAGs have been excavated and disposed of at ERDF. The remaining soils have been sampled, analyzed, and evaluated to show that residual concentrations will support future land uses that can be represented (or bounded) by a rural-residential scenario. The acceptability of unrestricted direct exposure to deep zone soils has not been demonstrated; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are required. These results also demonstrate that residual COC concentrations pose no threat to groundwater or the Columbia River.

4.32 116-B-6B, 111-B CRIB NO. 2

4.32.1 History

The 116-B-6B site was an inactive liquid waste site located 9.2 m (30 ft) southeast of the location of the former 111-B Building. The unlined crib received radioactive wastes from equipment decontamination performed in the 111-B Decontamination Station, as well as liquid wastes from the decontamination of fuel element spacers. Upon decommissioning, the crib was covered with approximately 1.8 m (6 ft) of soil. Historical documents describe the site as a crib partly or completely filled with coarse gravel.

4.32.2 Excavation Operations

Excavation of the 116-B-6B site began on March 11, 1999, by removing the materials and underlying contaminated soil. Based on field screening, materials identified as potentially clean were placed in stockpiles for potential use as backfill. Materials that were found to be contaminated have been disposed of at ERDF. The excavation was completed on March 12, 1999, and the area of the excavation floor was approximately 25 m² (270 ft²) at a depth of 3 m (9.8 ft). Approximately 263 metric tons (259 US tons) of material from the site were disposed of at ERDF.

4.32.3 Verification Sampling

Verification sampling consisted of composite samples formed by combining samples collected at four randomly selected nodes within each sampling area. Excavation of 116-B-6B did not extend into the deep zone; therefore, verification sampling took place only in the shallow zone above 3 m (9.8 ft).

4.32.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 116-B-6B site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." Materials that contain COCs at concentrations exceeding the RAGs have been excavated and disposed of at ERDF. The remaining soils have been sampled, analyzed, and evaluated to show that residual concentrations will support future land uses that can be represented (or bounded) by a rural-residential scenario. These results also demonstrate that residual COC concentrations pose no threat to groundwater or the Columbia River.

4.33 116-B-7, 132-B-6, AND 132-C-2 OUTFALL STRUCTURES

4.33.1 History

The 116-B-7, 132-B-6, and 132-C-2 Outfall structures consisted of open concrete structures that received reactor cooling water effluent, storm runoff, and sewer discharges and directed them to pipelines or spillways that emptied into the Columbia River.

The 116-B-7 Outfall was located at the top of the riverbank northwest of the 107-B Retention Basin. It was designed as an open concrete sump used to direct water through either the river discharge pipelines or spillways. Operations of the outfall were discontinued in 1972. After operations ceased, the outfall was fenced off and the concrete spillway was backfilled from the shoreline to the outfall.

The 132-B-6 Outfall was located north of the northeast corner of the 107-B Retention Basin and downstream of the 116-B-7 Outfall. It was designed as a concrete sump with an effluent line that

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ran from the outfall to the Columbia River. In addition, it included an overflow spillway that led to the top of the riverbank and a riprap flume that passed from the spillway to the edge of the river. This facility was used to support the 116-B-7 Outfall and received 105-B Reactor effluent. The outfall was backfilled to grade in 1978.

The 132-C-2 Outfall was located north of the 107-B Retention Basin and downstream from the 116-B-7 Outfall. In addition to two steel pipelines that discharged at the center of the Columbia River, it was designed with a concrete overflow flume that spilled effluent water onto a large basalt boulder riprap flume that extended to the river shoreline. In 1979, the outfall was reduced to near grade and backfilled.

The flume and exit pipeline from each outfall structure are not part of the outfall structure waste sites; they are listed as separate waste sites.

4.33.2 Excavation Operations

Remedial action at the outfall sites began on June 4, 2001. Excavation of the three outfall sites involved removing overburden materials and debris, contaminated structures, and underlying contaminated soil. Based on field screening, overburden materials identified as potentially clean were placed in stockpiles for potential use as backfill. Contaminated materials were disposed of at ERDF.

The elevation at the bottom of the 116-B-7 Outfall excavation was 124.8 m (409.5 ft), with a maximum backfill reference elevation of 132.3 m (434.1 ft). This excavation had a maximum depth of 8.3 m (27.2 ft) and an area of 1,638 m² (17,631 ft²). The elevation at the bottom of the 132-B-6 Outfall excavation was 123.9 m (406.5 ft), with a maximum backfill reference elevation of 132.0 m (433.1 ft). This excavation had a maximum depth of 7 m (23 ft) and an area of 1,634 m² (17,588 ft²). The elevation at the bottom of the 132-C-2 Outfall excavation was 124.8 m (409.47 ft), with a maximum backfill reference elevation of 131.0 m (429.8 ft). This excavation had a maximum depth of 7.0 m (23.0 ft) and an area of 1,094 m² (11,775 ft²). The combined area of the three outfall excavations was approximately 4,366 m² (46,995 ft²), with a maximum depth of 8.3 m (27.2 ft). Approximately 17,233 metric tons (18,996 US tons) of material from the sites were disposed of at ERDF.

The concrete flumes extending from each of the outfall structures to the Columbia River are a subsite of the 100-B-15 River Effluent Pipelines waste site and will be closed out at a later date. Portions of the flumes within the layback area of each excavation were removed to the extent necessary to facilitate removal of the outfall structures. The effluent pipelines leading to the outfalls were left in place and grouted at the ends. They were removed as part of the 100-B-8 and 100-C-6 pipelines remediation.

4.33.3 Verification Sampling

Based on agreement with the EPA, the three outfall excavations were sampled as one large site for the purposes of backfill concurrence and cleanup verification. The three sites received similar waste (reactor process effluent), and had the same identified COCs. Each verification

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sample was a composite formed by combining samples collected at four randomly selected nodes within each sampling area.

Cleanup verification sampling was conducted on January 14 and 15, 2002. Each outfall site (116-B-7, 132-B-6, and 132-C-2) contained both a shallow zone and a deep zone. The shallow zone decision unit consisted of the excavation sidewalls to a depth of 4.6 m (15 ft), and the deep zone consisted of the excavation sidewalls below 4.6 m (15 ft) together with the floor of each outfall excavation. All deep zone samples were collected below 4.6 m (15 ft). The shallow zone decision unit contained four decision subunits, which were divided into 16 sampling areas. The deep zone decision unit contained one decision subunit, which was divided into three sampling areas. One composite cleanup verification sample was collected from each sample area.

4.33.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 116-B-7 Outfalls have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." The remaining soils at the BC outfall sites have been sampled, analyzed, and evaluated. The results of this effort indicate that the materials from the BC outfall sites containing COCs at concentrations exceeding RAGs have been excavated and disposed of at ERDF. These results also indicate that residual concentrations in the shallow zone will support future land uses that can be represented (or bounded) by a rural-residential scenario, and that residual concentrations throughout the site pose no threat to groundwater or the Columbia River. The acceptability of unrestricted direct exposure to deep zone soils has not been demonstrated; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are required.

4.34 116-B-9, 104-B-2 FRENCH DRAIN

4.34.1 History

The 116-B-9 French Drain was a low-level liquid waste site that operated from 1952 to 1954. It was located west of the 132-B-1 Tritium Recovery Facility site, north of the 105-B Reactor building. The gravel-filled french drain was approximately 1 m (3 ft) deep and 1.2 m (4 ft) in diameter.

4.34.2 Excavation Operations

Excavation of the 116-B-9 French Drain began on March 10, 1999, by removing the overburden materials and underlying contaminated soil. Based on field screening, materials identified as potentially clean were placed in stockpiles for potential use as backfill. The excavation was completed on March 11, 1999. At the completion of the remedial action and removal of the engineered structure, the excavation area was approximately 51.5 m² (554 ft²) at a depth of approximately 2.4 m (8 ft).

4.34.3 Verification Sampling

Cleanup verification sampling consisted of composite samples formed by combining samples collected at four randomly selected nodes within each sampling area. Excavation of 116-B-9 did not extend into the deep zone; therefore, verification sampling took place only in the shallow zone above 2.4 m (8 ft).

4.34.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 116-B-9 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." Materials that contain COCs at concentrations exceeding the RAGs have been excavated and disposed of at ERDF. The remaining soils have been sampled, analyzed, and evaluated to show that residual concentrations will support future land uses that can be represented (or bounded) by a rural-residential scenario. The verification package also demonstrates that residual COC concentrations pose no threat to groundwater or the Columbia River.

4.35 116-B-10, 108-B DRY WELL

4.35.1 History

The 116-B-10 Dry Well was an inactive liquid waste site that was in use from 1950 to 1968. The dry well was constructed of a 61-cm (24-in.) vitrified clay pipe with a 3.8-cm (1.5-in.) drain line. This dry well was used to collect liquid decontamination wastes from the 108-B Tube Examination and Experimental Facility.

4.35.2 Excavation Operations

Excavation of the 116-B-10 Dry Well began on March 10, 1999, by removing the overburden materials and underlying contaminated soil. Based on field screening, materials identified as potentially clean were placed in stockpiles for potential use as backfill. Materials that were found to be contaminated were disposed of at ERDF. After completion of the initial excavation to design limits, several contaminated areas were discovered. These additional areas were excavated, and screened for contamination. The excavation was completed on May 19, 1999. At completion of the remedial action, the excavation area floor was approximately 153.4 m² (1,650.8 ft²) at a depth of approximately 2.4 m (8 ft), and approximately 692 metric tons (763 US tons) of material from the site had been disposed of at ERDF.

4.35.3 Verification Sampling

Cleanup verification sampling consisted of composite samples formed by combining samples collected at four randomly selected nodes within each sampling area. Excavation of 116-B-10 did not extend into the deep zone; therefore, verification sampling took place only in the shallow zone above 2.4 m (8 ft).

4.35.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 116-B-10 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." Materials that contain COPCs at concentrations exceeding the RAGs have been excavated and disposed of at ERDF. The remaining soils have been sampled, analyzed, and evaluated to show that residual concentrations will support future land uses that can be represented (or bounded) by a rural-residential scenario. The verification package also demonstrates that residual COPC concentrations pose no threat to groundwater or the Columbia River.

4.36 116-B-11, 107-B RETENTION BASIN

4.36.1 History

The 116-B-11 waste site was located near the northern edge of the 100-B Area and was approximately 170 m (558 ft) from the Columbia River. The 116-B-11 Retention Basin was constructed in 1944 to hold cooling water effluent from reactor for a brief period of time to allow for thermal cooling and radioactive decay prior to release to the Columbia River. The retention basin was a rectangular, reinforced-concrete reservoir measuring 142 m (467 ft) long and 70 m (230 ft) wide and 6 m (20 ft) deep. The basin was partially above ground and divided into two sections by a central flume that ran the length of the basin. The retention basin received reactor cooling water effluent from 1944 until 1954. Unplanned releases occurred as leaks from the basin and were first noticed in 1949. Leakage occurred in 1952 at the joints between the concrete slabs that made up the floors and walls and from the effluent line inlet.

In February 1954, the 116-B-11 Retention Basin was taken out of service after a break occurred in the basin and repair efforts to halt leakage to the soil column were unsuccessful. From 1954 until 1968, the 116-B-11 waste site was kept wet with overflow water from the reactor fuel storage basin. After the 105-B Reactor was shut down in 1968, subsequent decommissioning of the 116-B-11 waste site included placement of approximately 1.1 m (3.5 ft) of local soil (overburden) and partial demolition of the basin walls. Additional unspecified amounts of overburden were subsequently placed specifically for interim radiological, health, and safety protection purposes.

4.36.2 Excavation Operations

Excavation of the 116-B-11 waste site began on November 26, 1997, to remove overburden materials and underlying contaminated soil. All overburden materials were determined to be contaminated and were disposed of at ERDF. On October 28, 1998, removal of contaminated soil had reached the design limit at the base of the engineered structure. Soils not meeting direct exposure RAGs based on field screening results were excavated, loaded into shipping containers, and disposed of at ERDF.

Contaminated soil associated with the process effluent pipelines was partially removed; the rest remains for final remediation with pipelines and a separate cleanup verification package.

At the completion of the remedial action and removal of the engineered structure, the excavation area was approximately 14,000 m² (150,696 ft²) at a depth of 5.0 m (16.4 ft), and approximately 165,178 metric tons (182,109 US tons) of material from the site were disposed of at ERDF.

4.36.3 Verification Sampling

Cleanup verification sampling consisted of composite samples formed by combining samples collected at four randomly selected nodes within each sampling area. Verification sampling of the 116-B-11 Retention Basin was conducted in shallow zone and deep zone decision units. To simplify the cleanup verification efforts, the entire depth of the excavation sidewalls was considered to be in the shallow zone. The base of the excavation was 5.0 m (16.4 ft) below the top of the backfill datum elevation and was in the deep zone.

4.36.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 116-B-11 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." Materials that contain COCs at concentrations that exceed the RAGs have been excavated, sampled, analyzed, and, where required, the materials were removed and shipped to ERDF. The remaining soil has been sampled, analyzed, and evaluated to show that no residual COC concentrations in vadose zone soils pose a threat to human health, groundwater, or the Columbia River. The acceptability of unrestricted direct exposure to deep zone soils has not been demonstrated; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are required.

4.37 116-B-12, 117-B CRIB

4.37.1 History

The 116-B-12 Crib was located east of the 100-B Reactor and was near the 118-B-5 Burial Ground. The crib was constructed in 1961 and was operational from 1961 to 1968. The crib received drainage from the confinement system seal pits in the 132-B-4 Air Filtration

Construction Activity Summary

Ventilation Building. The crib was approximately 3 m (10 ft) long, 3 m (10 ft) wide, and 3 m (10 ft) deep. Historical sampling data for the 116-B-12 waste site conducted in 1978 indicated no contamination above background levels.

4.37.2 Excavation Operations

Excavation of the 116-B-12 waste site began on February 17, 1999, by removing the overburden materials and underlying contaminated soil. Based on field screening, materials identified as potentially clean were placed in stockpiles for potential use as backfill. Contaminated materials were disposed of at ERDF. Excavation was completed on March 15, 1999. At the completion of the remedial action, the excavation floor area was approximately 520.8 m² (5,605.8 ft² [0.129 ac]) at a depth of approximately 4.6 m (15 ft), and approximately 8,696 metric tons (9,586 US tons) of material from the site had been disposed of at ERDF.

4.37.3 Verification Sampling

Cleanup verification sampling began on March 15, 1999, and was finished on April 13, 1999. Each verification sample was a composite formed by combining samples collected at four randomly selected nodes within each sampling area. Verification sampling of the 116-B-12 Crib was conducted in shallow zone and deep zone decision units. To simplify the cleanup verification efforts, the entire depth of the excavation sidewalls was considered to be in the shallow zone. The base of the excavation was 4.6 m (15 ft) below the top of the backfill datum elevation and was in the deep zone.

4.37.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 116-B-12 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." Materials that contain COCs at concentrations exceeding the RAGs have been excavated and disposed of at ERDF. The remaining soils have been sampled, analyzed, and modeled to show that residual concentrations will support future land uses that can be represented (or bounded) by a rural-residential scenario. The acceptability of unrestricted direct exposure to deep zone soils has not been demonstrated; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are required. The verification package also demonstrates that residual COC concentrations pose no threat to groundwater or the Columbia River.

4.38 116-B-13, 107-B SOUTH SLUDGE TRENCH

4.38.1 History

The 116-B-13 Trench was located about 220 m (725 ft) from the Columbia River. The trench was a 232-m² (2,500-ft²) by 3-m (10-ft) deep unlined excavation that received radioactive sludge wastes in 1952. The trench was built to receive the sludge removed from the bottom of the

107-B Retention Basin. There is no indication from available records that the trench directly received any regular and/or high-volume liquid effluent wastes. After its use, the waste site was covered with about 1.8 m (6 ft) of soil.

4.38.2 Excavation Operations

Excavation of the 116-B-13 waste site began on August 7, 1998, by removing the overburden materials and underlying contaminated soil. Based on field screening, overburden materials that were identified as potentially clean were placed in stockpiles for potential use as backfill. Overburden materials that were found to be contaminated were disposed of at ERDF. The excavation was completed on November 6, 1998, at the base of the engineered structure.

At the completion of the remedial action, the excavation footprint area was approximately 620 m² (6,674 ft²) at a depth of 4.3 m (14 ft), and approximately 6,340 metric tons (6,989 US tons) of material from the site were disposed of at ERDF.

4.38.3 Verification Sampling

Cleanup verification sampling consisted of composite samples formed by combining samples collected at four randomly selected nodes within each sample area. Excavation of 116-B-13 did not extend into the deep zone; therefore, verification sampling took place only in the shallow zone above 4.3 m (14 ft).

4.38.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 116-B-13 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." Materials that contain COCs at concentrations that exceed the RAGs have been excavated, sampled, analyzed, and, where required, the materials were removed and shipped to ERDF. The remaining soil has been sampled, analyzed, and evaluated to show that no residual COC concentrations in vadose zone soils pose an unacceptable threat to human health, groundwater, or the Columbia River.

4.39 116-B-14, 107-B NORTH SLUDGE TRENCH

4.39.1 History

The 116-B-14 Trench was located about 96 m (315 ft) from the Columbia River. The trench was a 122-m² (1,310-ft²) by 3-m (10-ft) deep unlined excavation that received radioactive sludge wastes in 1948. The trench was built to receive the sludge removed from the bottom of the 107-B Retention Basin. There is no indication from available records that this sludge pit directly received any regular and/or high-volume liquid effluent wastes. After its use, the waste site was covered with about 1.8 m (6 ft) of soil.

4.39.2 Excavation Operations

Excavation of the 116-B-14 waste site began on May 27, 1998, by removing the overburden materials and underlying contaminated soil. Overburden materials, which were contaminated, were disposed of at ERDF. Excavation was completed on September 17, 1998, below the base of the engineered structure.

At the completion of the remedial action, the excavation area floor was approximately 132 m² (1,422 ft²) at a depth of 6 m (19.7 ft), and approximately 3,795 metric tons (4,183 US tons) of material from the site were disposed of at ERDF.

4.39.3 Verification Sampling

Cleanup verification sampling consisted of composite samples formed by combining samples collected at four randomly selected nodes within each sampling area. Verification sampling of the 116-B-14 Sludge Trench was conducted in shallow zone and deep zone decision units. To simplify the cleanup verification efforts, the entire depth of the excavation sidewalls was considered to be in the shallow zone. The base of the excavation was 6 m (19.7 ft) below the top of the backfill datum elevation and was in the deep zone.

4.39.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 116-B-14 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." Materials that contain COCs at concentrations that exceed the RAGs have been excavated, sampled, analyzed, and, where required, the materials were removed and shipped to ERDF. The remaining soil has been sampled, analyzed, and evaluated to show that no residual COC concentrations in vadose zone soils pose a threat to human health, groundwater, or the Columbia River.

4.40 116-B-15, 105-B FUEL STORAGE BASIN CLEANOUT PERCOLATION PIT AND DISCHARGE POND**4.40.1 History**

The 116-B-15 waste site was a 1.8-m (6-ft) deep depression in the landscape, approximately 68 m (230 ft) long by 40 m (130 ft) wide, and located 150 m (490 ft) east of the 105-B Reactor building. The site was active from November 1984 to December 1985, during which time it received processed water from the 105-B Fuel Storage Basin. The water from the basin was processed through an ion-exchange system and sampled before being discharged to the 116-B-15 Percolation Pit.

4.40.2 Investigation

Confirmatory sampling activities were conducted in March 2003. A stratified sampling approach was selected for this site, consisting of judgmental sampling in combination with hot spot systematic sampling. Four test pits (three pits systematically located and one judgmentally located) were excavated and soil samples were collected from each pit. Field screening using laser-assisted ranging and data system was conducted to detect areas of elevated activity.

Process knowledge, field observations, and radiological survey instruments were used to identify locations to collect cleanup verification samples of underlying soil at locations of the 116-B-15 waste site with the greatest potential for residual contamination. In accordance with the stratified sampling approach and the WAC 173-340-740(7)(d)(iii), direct comparison of the cleanup verification sample results with the RAGs is an appropriate method to evaluate compliance with cleanup objectives for the 116-B-15 waste site.

4.40.3 Statement of Protectiveness

The confirmatory sampling results demonstrate that the 116-B-15 waste site meets the objectives for no action as established in the interim action ROD and the site has been reclassified as "No Action." These results show that residual soil concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario. The results also demonstrate that residual contaminant concentrations support unrestricted future land uses of shallow zone soil and contaminant levels remaining in the soil are protective of groundwater and the Columbia River.

4.41 118-B-5, BALL 3X BURIAL GROUND

4.41.1 History

The 118-B-5 Burial Ground was an inactive solid waste burial ground located 46 m (150 ft) east of the 115-B Gas Recirculation Building site and 80 m (265 ft) southeast of the 105-B Reactor building. The burial ground was in operation in 1953 and was commonly known as the Ball 3X Burial Ground.

The dimensions of the 118-B-5 Burial Ground were 15 m (50 ft) long, 15 m (50 ft) wide, and 6.1 m (20 ft) deep. The burial ground received approximately 40 m³ (1,412 ft³) of contaminated metallic wastes, including thimbles and step plugs, that were removed from the 105-B Reactor during performance of work for the Ball 3X Project. The Ball 3X Project replaced the liquid boron system for emergency reactor control with a system using solid, nickel-plated, boron-steel, and carbon-steel balls.

Previous investigations at the 118-B-5 Burial Ground included a 2001 geophysical survey and a magnetic inductance survey, which identified two areas that had characteristics of buried debris.

Construction Activity Summary

The first area of suspected debris was 6 m (20 ft) long and 2 m (6 ft) wide, the second covered an area approximately 2 m (6 ft) long and 2 m (6 ft) wide.

4.41.2 Excavation Operations

Remedial action at the 118-B-5 Burial Ground began in November 2003. Excavation of the site involved removing the buried equipment and buried wastes (including lead solids). One staging pile area was used to support remedial action operations at the 118-B-5 Burial Ground. Excavated waste was temporarily staged adjacent to the site excavation prior to disposal at ERDF.

Excavation was completed in December 2003, with an average elevation at the bottom of the excavation of 141.7 m (465 ft). The excavation was approximately 753 m² (8,101 ft²) in area for the shallow zone and approximately 3,419 m² (37,783 ft²) in area for the staging pile area. The burial ground was excavated to a depth of approximately 4.8 m (15.7 ft). Approximately 5,046 metric tons (5,563 US tons) of material from the site were disposed of at ERDF.

4.41.3 Verification Sampling

A focused soil sample was collected from the excavation in an area where waste with potentially leachable metals (i.e., lead) was removed. An additional soil sample was collected from beneath the area where the lead solids were staged during remediation. The purpose of focused sampling and analysis was to verify that soil directly underlying these areas had not been impacted.

A sampling design using random sampling within blocks was conducted for the shallow zone and staging pile decision units following field screening at the 118-B-5 Burial Ground. Each decision unit was divided into four blocks or sample areas and four samples were collected and composited from each block.

There was a small area within the site that qualified as a deep zone; however, it was closed out under the shallow zone criteria to save time and resources. The site was excavated to a maximum depth of approximately 4.8 m (15.7 ft), with the shallow zone consisting of the excavation sidewalls together with the floor of the excavation.

4.41.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 118-B-5 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." The remaining soils at the burial ground, including the staging pile area were sampled, analyzed, and evaluated. The results of this effort indicate that the materials from the burial ground containing COCs at concentrations exceeding the RAGs have been excavated and disposed of at ERDF. These results also indicate that residual concentrations will support future land uses that can be represented or bounded by a rural-residential scenario, and that residual concentrations throughout the site are protective of groundwater and the Columbia River.

4.42 118-B-7, 111-B SOLID WASTE BURIAL SITE

4.42.1 History

The 118-B-7 Solid Waste Burial Ground was also known as the 111-B Solid Waste Burial Ground. The 111-B Facility was originally used as a charge makeup and reactor fuel inspection station; however, after 1 year, it was used as a decontamination facility for equipment and a workshop for low-level contaminated equipment. The solid waste burial ground received small amounts reactor hardware, decontamination material, and associated equipment from the 111-B Facility.

4.42.2 Investigation

Within remedial action design documents, there were two possible locations identified for the 118-B-7 Burial Ground. One location was near the C-Reactor effluent lines close to the 116-B-6B site, and the other was just southwest of the 111-B Decontamination Station.

The location identified near the C-Reactor effluent lines fell within the pipeline removal corridor. In 2003, this location was first potholed, and then excavated during the remediation of the pipelines. Nothing was found at this location to suggest the presence of a burial ground. This did not appear to be a likely location due to the proximity to the C-Reactor effluent lines.

Two trenches were excavated near the 111-B Decontamination Station. One trench was excavated in a north-south orientation and was 1.5 to 2.4 m (5 to 8-ft) deep and 6 m (20-ft) long. A french drain was encountered and removed. The other trench was excavated in an east-west orientation and was 0.8 m (2.5 ft) deep and 10.7 m (35 ft) long. Native soil was encountered at 0.8 m (2.5 ft). A composite sample was collected from the soil from the middle and ends of each trench. Analytical results were at or below background for metals and nondetects for radionuclides.

All available information, including WIDS references, aerial photographs, and field conditions were reviewed to identify any other potential location for the burial ground. A photograph was located that had a posting for an area 2.4 by 2.4 m (8 by 8 ft) just south of 111-B Decontamination Station and was identified as the 118-B-7 Burial Ground. A global positioning system was used to locate the center of the posted area and a pothole was dug to native soil. Another french drain was encountered. No solid waste was found. Two samples were collected, one of the material from the french drain and one of the native soil.

A review of drawings associated with 111-B Decontamination Station showed there were five french drains related to steam condensate from the 355.6-cm (140-in.) long wall-mounted radiators. Analytical results from the second french drain and associated soils were at or below background levels except for one lead result that was less than twice background and less than 10% of the cleanup value. No solid waste burial ground was found. If another location should be discovered for this burial ground, the information will be added to WIDS and the site will be remediated.

4.42.3 Statement of Protectiveness

Based on this investigation the 118-B-7 Solid Waste Burial Ground was approved for "Rejected" reclassification by DOE-RL and EPA in December 2004. No institutional controls are required for this site to prevent uncontrolled drilling or excavation into deep zone.

4.43 118-B-9, 104-B-1 TRITIUM VAULT AND 104-B-2 TRITIUM LABORATORY**4.43.1 History**

The 118-B-9 waste site was a gravel-covered field north of the 105-B Reactor. Originally, there were two concrete masonry facilities identified as 104-B-1 Tritium Vault and 104-B-2 Tritium Laboratory. In 1996, both structures were demolished and their associated foundations removed to 0.9 m (3 ft) below grade. The excavated areas were then backfilled and graded to match the existing terrain.

4.43.2 Investigation

A focused sampling approach was selected for this site, consisting of two test pits randomly located and two test pits judgmentally located for sample collection. Confirmatory sampling was conducted at the 118-B-9 waste site in September 2003. One of the two judgmentally located sampling locations was in the center of the 104-B-1 Tritium Vault site and the second was below the exhaust vent pipe of 104-B-2 Tritium Laboratory site. The randomly located test pits were dug under the former location of the floor storage cells of the 104-B-2 Tritium Laboratory site. The maximum detected result for each COPC from the four soil samples was used to support site reclassification.

4.43.3 Statement of Protectiveness

In accordance with this evaluation, the confirmation sampling results from soil samples support a "No Action" reclassification of the 118-B-9 waste site. The current site soil conditions achieve the RAOs and the corresponding RAGS established in interim action ROD. These results show that residual concentrations will support future unrestricted land uses that can be represented (or bounded) by a rural-residential scenario. The results also demonstrate that residual contaminant concentrations support unrestricted future use of shallow zone soil to 4.6 m (15 ft), and contaminant levels remaining in the soil are protective of groundwater and the Columbia River. Site contamination did not extend into the deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

4.44 118-B-10 BALL 3X STORAGE VAULT

4.44.1 History

The 118-B-10 Ball 3X Storage Vault was located approximately 23 m (75 ft) north of the 115-B Gas Recirculation Building and 24 m (80 ft) south of the 105-B Reactor building. Historical records indicated that the site contained a metal tank used to store highly radioactive boron-steel and carbon-steel balls. However, excavation of the site found only boron-steel balls mixed with soil. The site was believed to be approximately 15 m (50 ft) long, 6.1 m (20 ft) wide, and 6.1 m (20 ft) deep. The 118-B-10 waste site was approximately 820 m (2,690 ft) south of the Columbia River. Operational dates of this site are unknown.

4.44.2 Excavation Operations

Remedial action at the 118-B-10 waste site began on December 1, 2003, and consisted of excavation of overburden and burial ground materials. Based on field screening, excavated waste was temporarily staged adjacent to the site excavation prior to disposal at ERDF.

Excavation was completed on December 2, 2003, with a final elevation at the bottom of excavation of approximately 141.3 m (463.6 ft). The excavation was approximately 137 m² (1,475 ft²) with an average depth of approximately 3.2 m (10.5 ft). Approximately 266 metric tons (293 US tons) of material were removed from the 118-B-10 waste site and disposed of at ERDF.

4.44.3 Verification Sampling

Cleanup verification sampling was done on January 14, 2004. Each verification sample was a composite formed by combining samples collected at four randomly selected nodes within each sampling area.

The waste site was divided into two decision units: the shallow zone and staging pile area. Since the 118-B-10 waste site did not require excavation below 4.6 m (15 ft), a deep zone unit was not required. The shallow zone unit contained one decision subunit, which was divided into four sampling areas. The staging pile area contained one decision subunit, which was also divided into four sampling areas. One composite cleanup verification sample was collected from each shallow zone and staging pile sample area.

4.44.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 118-B-10 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." The remaining soils at the site, including the staging pile area, were sampled, analyzed, and evaluated. The results of this effort indicate that the materials from the site containing COCs at concentrations exceeding the RAGs have been excavated and disposed of at ERDF. These results also indicate that residual concentrations will support future land uses that can be represented or bounded by a rural-residential scenario,

and that residual concentrations throughout the site are protective of groundwater and the Columbia River.

4.45 120-B-1, 105-B BATTERY ACID SUMP

4.45.1 History

The 120-B-1, 105-B Battery Acid Sump waste site was a standard limestone acid neutralization pit with metal cover plates at grade. It was used from approximately 1944 to 1969 to neutralize spent sulfuric acid from lead cell batteries from emergency power packs and emergency lighting systems. The sump was a 3.9 m (12.8 ft) long, 2.1 m (6.8 ft) wide, and 2.5 m (8 ft) deep concrete box with hinged metal covers on top. It was divided into two sections, one about 0.8 m (2.5 ft) long (south section) for receiving spent sulfuric acid waste solutions and the other about 3.1 m (10 ft) long (north section) for holding limestone (calcium carbonate). The partition wall between the north and south section had slots at the bottom and top that allowed liquid waste to flow over the top of the partition, down through the bed of limestone, and back into the liquid waste storage section. The interior sump walls were lined with acid-resistant brick. An air sparger in the bottom of the liquid section of the box was used to promote circulation of the liquid waste down through the limestone bed to neutralize the spent sulfuric acid from lead cell batteries. The neutralized battery acid waste (containing calcium sulfate, metal sulfates, and water) was periodically jetted out (using a water-operated eductor) to the process sewer.

The residual liquid and sludge were analyzed for heavy metals in 1986 and found to contain chromium. The sump was cleaned out in 1986. The residual limestone was removed and both the solution section (south end) and the solids (limestone) section (north end) were flushed with water and jetted out to the process sewer using the sump's water-operated eductor. The air and water supply to the sump (air sparger and water eductor) were shut off. The sump contained a 10-cm (4-in.) waste inlet pipe from the 105-B Building; it was located in the south wall of the sump about 50.8 cm (20 in.) below the metal access doors. The sump contained an outlet pipe near the top of the west wall of the northern section of the sump.

The 120-B-1 waste site was located adjacent to the northwest corner of the 105-B Reactor building. The sump was opened in March 2003 to support confirmatory sampling. Standing water was present in both sections of the sump. In June 2006, approximately 6,400 L (1,700 gal) of standing water present in the sump was treated with lime to adjust the pH and removed.

4.45.2 Excavation Operations

The 120-B-1 waste site consisting of the sump structure along with a small volume of soil directly in contact with the sump was excavated in June 2006. The site was excavated to a maximum depth of 3.0 m (10 ft) below ground surface in order to preclude any potential impact to the integrity of the 105-B Building walls and nearby transformer pad. The pipelines were removed to the extent of the excavation boundaries and grouted prior to backfilling. Approximately 32 BCM (42 BCY) of material were excavated and disposed at ERDF.

The inlet and outlet pipelines associated with the sump were sampled but are not included as part of the closeout for the 120-B-1 waste site. The inlet and outlet pipelines were grouted and are included as a subsite within 118-B-8, 105-B Reactor building waste site.

4.45.3 Verification Sampling

Verification sampling was performed at the 120-B-1 waste site on June 13, 2006. The verification sample design called for focused soil samples to be collected from the excavation boundaries (i.e., sidewalls and floor). A total of six samples (one from each sidewall and two from the excavation floor) were collected from the remediation footprint. In addition, one sample of the sediment present within the inlet pipeline was collected.

4.45.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 120-B-1 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." The results of verification sampling show that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils. The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. Site contamination did not extend into the deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required. The pipelines associated with the battery acid sump are not included as part of the 120-B-1 waste site, but are included as a subsite within 118-B-8, 105-B Reactor building, waste site.

4.46 126-B-1, 184-B POWER HOUSE ASH PIT

4.46.1 History

The 126-B-1 Ash Pit was a large vegetation-covered depression with surrounding ash piles. The depression was approximately 60 m (200 ft) long, 60 m (200 ft) wide, and 3 m (10 ft) deep. An earthen berm divides the site into two sections. The pit was bounded on the north, east, and west sides by three large ash piles that extend 9 to 10 m (30 to 33 ft) high. On the west side of the pit was a large wooden ramp that was in a state of disrepair. A large pipe entered the depression in the southwest corner. Including the surrounding ash piles, site dimensions are approximately 200 by 200 m (650 by 650 ft). The site was in use from 1944 to 1969 for disposal of coal ash.

4.46.2 Investigation

Analyses of Hanford Site coal ash from 126-D-1 waste site and other ash piles have shown no evidence of hazardous, dangerous, or radioactive waste. Extraction procedure toxicity tests indicate that all sample results are well below the minimum extract concentration for designation as extraction procedure toxic material per WAC 173-303.

4.46.3 Statement of Protectiveness

The 126-B-1 Ash Pit was reclassified as a "Rejected" waste site and requires no additional action to meet the cleanup standards specified in the Remaining Sites ROD (EPA 1999). No institutional controls are required for this site to prevent uncontrolled drilling or excavation into deep zone.

4.47 126-B-2, 183-B CLEARWELLS**4.47.1 History**

The 126-B-2 Clearwells are located approximately 430 m (1,410 ft) directly west of the 105-B Reactor building and southeast of the 182-B Retention Basin. The clearwells were in operations from 1944 to 1968 and consists of two underground concrete reservoirs separated in the center by the remains of a demolished pump room. Concrete piping structure remains above ground at the southeast corner of the clearwell site. The concrete roof of the clearwells is finished with asphalt and mastic sealant and is suspected ACM. The suspect ACM is nonfriable and does not present a potential release to the environment.

4.47.2 Investigation

Based on an evaluation which included process knowledge, historical drawings, and site visits, it was concluded that no contamination or suspected contamination is associated with the 126-B-2 waste site.

4.47.3 Statement of Protectiveness

The investigation confirms that the 126-B-2 waste site meets the objectives for a "No Action" reclassification. Also, the residual soil concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario. The evaluations also demonstrate that residual contaminant concentrations support unrestricted future use and that contaminant levels remaining in the soil are protective of groundwater and the Columbia River.

4.48 126-B-3, 184-B COAL PIT**4.48.1 History**

The 126-B-3 waste site was located approximately 450 m (1,500 ft) northwest of the 105-B Reactor building and 75 m (250 ft) west of the former 184-B Powerhouse. This site was originally excavated to store coal for use in the 184-B Powerhouse and served in this capacity from 1943 through 1968. During demolition operations in the 1970s, the pit was used for disposal of demolition debris from 100-BC Area facilities. The majority of the debris was from the radiologically released portions of the 108-B Laboratory Building and

Tritium Separation Facility, the 117-B and 117-C Filter Buildings, the 115-B/C Gas Recirculation Building, and the 184-B Powerhouse (Carpenter 1994).

4.48.2 Excavation Operations

Remediation of the 126-B-3 waste site was performed from September 4 to September 17, 2003, and remediation of the remainder of the site was performed from October 4 to December 27, 2004, with loadout continuing to July 2005. Remediation consisted of the removal of suspect hazardous material and impacted soils within the disposal pit to depths of approximately 7 m (23 ft). Material removed included batteries, lead bricks, rubber gaskets, a compressor, metal scrap, concrete rubble, miscellaneous asbestos-containing material, ash, and contaminated soil. Approximately 43,100 BCM (56,400 BCY) of material was excavated and staged onsite before disposal at ERDF.

During loadout of material staged in the northern portion of the western staging area, suspect chromium-staining was identified in underlying soils. Additional material was removed by scraping an approximately 0.5-m (1.5-ft) thick layer of soil from the entire area. During soil removal, a suspect drywell unrelated to the 126-B-3 waste site was also discovered and removed. Approximately 4,640 BCM (6,060 BCY) of additional soil was removed and disposed at ERDF. Since the contamination was unrelated to disposal or remediation staging activities at the 126-B-3 waste site, and the extent of contamination was unknown, this area was subsequently designated as the 100-B-27 waste site.

4.48.3 Verification Sampling

Verification sampling at the 126-B-3 waste site remediation footprint was performed on April 15, 2005, to evaluate if the RAOs had been reached. Verification sampling at the staging pile footprints was performed on August 9, 2005, and February 7 and 14, 2006.

Fifteen soil sample locations were identified for the remediation footprint and 10 soil sample locations were identified for the staging pile footprints using random-start triangular grids. Initial verification sampling results indicated that hexavalent chromium concentrations in the eastern staging pile footprint exceeded cleanup criteria. Following additional material removal, 11 new soil sample locations were identified for this area using a random-start triangular grid and analyzed for hexavalent chromium analysis only. A biased soil sample was also collected from beneath the suspect drywell discovered in the eastern staging pile footprint.

4.48.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 126-B-3 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." The results of verification sampling show that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils. The results also demonstrate that residual contaminant concentrations are protective of groundwater and

the Columbia River. Deep zone portions of this site meet the direct exposure cleanup criteria for the rural-residential scenario; therefore, no deep zone institutional controls are required.

4.49 126-B-4, B AREA BRINE AND SALT DILUTION PITS

This site originally consisted of a single below-grade concrete structure that provided brine for the 184-B Powerhouse. Before its demolition in 1988, the structure was surveyed and sampled for radiological and hazardous materials. No radiation above background and no reportable quantities of heavy metals were found, and the site was reclassified as "Rejected."

4.50 128-B-1, 100-BC BURNING PIT

This site was originally identified as a burning pit. A number of ground evaluations, including one with representatives from the Tri-Parties, could not substantiate its existence. There are indications that, because of poor mapping, this site is actually the 128-B-3 Burn Pit. It was concluded that the 128-B-1 Burn Pit did not exist as a separate, discrete site, and was reclassified as "Not Accepted."

4.51 128-B-2, 100-B BURN PIT #2

4.51.1 History

The 128-B-2 waste site, also referred to as 100-B Burn Pit #2, was historically used for the disposal of combustible and noncombustible waste. The operational history of the 128-B-2 waste site is not completely known, but according to information in WIDS, the site was known to have been used from 1948 to 1968 as a burn pit for office and paint wastes, chemicals, and solvents. Landfilled noncombustible material, including concrete and metallic debris, was also discovered during remediation of the site. The presence of garnet sand also suggests that sandblasting activities may have been performed at this site. The site is located east of the northeast corner of the 100-B Area, at the intersection of two historic road beds north of Route 1.

4.51.2 Excavation Operations

Remedial action of the 128-B-2 waste site was initiated in November 2004 and continued through April 2005 with 5,627 BCM (7,360 BCY) of material excavated and disposed at ERDF. Scrap metal, wood debris, tar paper, copper wire, plastic pipe, colored sand (believed to be garnet or other sandblasting abrasive), concrete rubble, cyclone fencing, barbed wire, bricks, vitrified clay pipe tiles, fence posts, potentially contaminated soil, and other miscellaneous materials were removed. Excavated materials were sorted and segregated based on visual inspection and site location and staged onsite for transport to the ERDF.

The site was excavated to a maximum depth of 3.5 m (11.5 ft) at areas of buried foreign material. Surficial soils surrounding the primary excavations were also removed to a depth of 0.30 to 0.45 m (1 to 1.5 ft) due to the presence of visible surficial foreign material.

4.51.3 Verification Sampling

Verification sampling for the 128-B-2 waste site was performed on June 8, 2005. The site was into two sampling areas for purposes of verification sampling. Area 2 was delineated based on the surveyed limits of material removal, and area 1 comprises the remaining portion of the waste staging area. A total of 22 soil samples were collected in random-start triangular grids with each sample consisting of 25 aliquots of soil.

4.51.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 128-B-2 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." The results of verification sampling show that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils. The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. Site contamination did not extend into the deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

4.52 128-B-3, COAL ASH AND DEMOLITION WASTE SITE

4.52.1 History

The 128-B-3 waste site was a former disposal site for the 100-BC Area. The operational history of the waste site is poorly documented, but assumed to be coincident with 100-BC Area operations from 1943 to 1968. The site was used for the disposal of combustible and noncombustible wastes, including office waste, paints, solvents, coal ash, and demolition debris.

4.52.2 Excavation Operations

Initial remediation of the 128-B-3 waste site was performed in November 2004. Excavation consisted of removal of surface material and waste from four former disposal pits. During remedial efforts, a previously unknown prehistoric cultural site, consisting of a shell midden with stone tools, was discovered in the vicinity of one of the former disposal pits. Further remediation of the waste site was performed so as to preclude further impact to this resource. Approximately 8,810 BCM (11,520 BCY) of soil and debris were removed from the waste site and staged onsite before disposal at ERDF. Waste staging included segregating lead, tar, and asbestos materials, as well as general waste staging piles.

Construction Activity Summary

A geophysical survey was performed at the site in February 2005, following initial site remediation. Data were collected using electromagnetic induction and magnetometry to identify potential residual subsurface debris. Anomalies detected in the site area above the riverbank were determined to result primarily from the large basalt boulders present at the site. No indications of any large concentrations of subsurface debris were observed in this area. Significant geophysical anomalies were detected along the riverbank area, partially attributable to surface material, but also indicative of subsurface foreign material.

In-process samples collected from stained soils and debris at the river embankment adjacent to the initial remediation footprint indicated the presence of hazardous constituents at levels exceeding RAGs. The scope of the remedial effort was extended to include this embankment area. Additional remediation along the river embankment was performed from October to November 2005, with approximately 8,700 BCM (11,380 BCY) of material excavated and disposed at ERDF.

Following completion of calendar year 2005 remedial activities, statistical sampling was performed at the river embankment and disposal pits to ascertain if RAGs had been met (as described below). Sample results indicated residual concentrations of site COCs at concentrations exceeding cleanup criteria. Accordingly, approximately 3,500 BCM (4,600 BCY) of additional material was removed from these areas in April and May 2006.

4.52.3 Verification Sampling

Phase I verification sampling was performed in 2005 within the excavated disposal pits and river embankment area at the 128-B-3 waste site to make an initial evaluation of the attainment of RAOs. A total of 20 sample locations were selected based on random-start systematic grids.

Phase II verification sampling for the 128-B-3 waste site was performed from June to August 2006. The site was divided into seven sampling areas. A statistical sampling design approach was implemented for sampling areas 1 through 4, as described below. A total of 47 soil sample were collected in random-start triangular grids with each sample consisting of 30 aliquots of soil. Ten soil sample locations were identified for each of sampling areas 1, 2, and 4; and 17 sample locations were identified for sampling area 3.

The sampling designs for sampling areas 5 through 7 were based on professional judgment. Sampling at each special waste staging pile footprint consisted of one sample composed of 30 aliquots of surficial soils collected from locations distributed across the entire staging footprint.

4.52.4 Statement of Protectiveness

Sample results for upland areas were shown to meet the cleanup objectives for direct exposure, groundwater protection, and river protection. Analytical results for the remediated river embankment were shown to meet the cleanup objectives for direct exposure and to not significantly exceed soil RAGs for protection of groundwater and the Columbia River.

This evaluation concluded that further remedial action to remove additional soils would likely pose a greater risk to human health and the environment than leaving soils in place and backfilling the site. Accordingly, the "Interim Closed Out" reclassification was supported for the 128-B-3 waste site, with imposition of institutional controls on the river embankment area to prevent activities that would mobilize residual contaminants to travel to groundwater or the river. Institutional controls will be maintained until such time that the results of a baseline risk assessment can be considered (for a final site remedy or closure). The remainder of the site does not have residual contaminant concentrations that would require any institutional controls.

4.53 132-B-1, 108-B TRITIUM SEPARATION FACILITY

4.53.1 History

The 132-B-1 waste site was the former 108-B Tritium Separation Facility located north of the 105-B Building. Demolition and site grading were completed in 1985 using conventional heavy equipment. The uncontaminated rubble was buried under at least 1 m (3 ft) of clean fill and the site was graded to blend with the natural terrain. The 108-B Building was released for unrestricted use based on the post-decontamination radiological results and the direct, removable, and dispersed contamination limits specified in *Radiological Criteria for Decontamination and Decommissioning of the Retired 108-B Building* (UNI 1984).

4.53.2 Investigation

Based on the available laboratory sample results, RESidual RADioactivity (RESRAD) modeling was performed in 2003 to support the no action decision. The RESRAD evaluation accounted for radioactive decay from 1985 (the year of building demolition) to 2003 and predicted that the dose limits for the rural residential (15 mrem/yr) and groundwater (4 mrem/yr) pathways will not be exceeded. Since representative laboratory sample results were not available to assess groundwater protection for tritium, a supplemental evaluation was performed to support reclassification. Three groundwater monitoring wells down gradient from the 132-B-1 waste site show that tritium concentrations reached a maximum of 200,000 pCi/L in the mid 1980s and decreased to below 20,000 pCi/L (the drinking water limit), by the late 1980s. Groundwater sampling from these wells was discontinued in 1994. This trend in groundwater tritium concentrations indicated that there is no active source of tritium in the vadose zone in the general vicinity of the 132-B-1 waste site.

The RESRAD model results indicate that the residual contamination levels do not present any risk to the maximally exposed individual, and are protective of groundwater and the Columbia River (excluding evaluation of tritium). Very conservative inputs were used for the RESRAD modeling inputs including the highest activity sample results available and a contaminated zone depth of 2.7 m (8.9 ft), which represents 100% of the material buried beneath the 1 m (3 ft) clean soil fill and the bottom of the site. The contaminated zone thickness is possibly overestimated by two orders of magnitude based on information from other

100-Area sites, an expected contaminant penetration depth of less than 1 cm (0.4 in.), and presence of clean areas within the 108-B Building.

4.53.3 Statement of Protectiveness

The results of the investigation confirm that the 132-B-1 waste site achieves the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "No Action." Any residual concentrations will support future land uses that can be represented (or bounded) by a rural-residential scenario and that, based on RESRAD modeling, pose no threat to groundwater or the Columbia River.

4.54 132-B-3, 108-B VENTILATION EXHAUST STACK SITE

4.54.1 History

The 108-B ventilation exhaust stack and foundation were demolished, buried in a trench, and covered with clean soil in 1983.

4.54.2 Investigation

Before demolition, surveys were conducted in the void beneath the liner and in the area inside the stack from the bottom of the liner to the 4.9 m (16 ft) level. After removal of a layer of dust and dirt from an area around the liner floor drain, direct beta-gamma readings were <100 cpm/probe area inside the stack up to the 4.9 (16 ft) level. Alpha radiation was not detected with portable survey instruments. To determine the depth of penetration, concrete cores were collected from the inner stack surface to a depth of 1 cm (0.4 in.) at the 10.4 m (32 ft) and 19.5 m (64 ft) levels and submitted for analysis. In addition, a sample from the 19.5 m (64 ft) level was analyzed for tritium, carbon-14, and strontium-90. The contamination did not penetrate greater than 1 cm (0.4 in.) at the core locations. The "allowable residual contamination level" (ARCL) calculation methodology was used to determine if further decontamination or remedial action was needed. The ARCL resulted in a calculated residual activity that corresponds to an estimated dose of 2.2 mrem/yr. The total radionuclide inventory was calculated to be 21 millicuries; therefore, the burial site met the release criteria for unrestricted use.

4.54.3 Statement of Protectiveness

The results of the investigation confirm that the 132-B-3 waste site achieves the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "No Action." Any residual concentrations will support future land uses that can be represented (or bounded) by a rural-residential scenario and that, based on RESRAD modeling and ARCL evaluation, pose no threat to groundwater or the Columbia River.

4.55 132-B-4, 117-B FILTER BUILDING

4.55.1 History

The 117-B Filter Building was constructed to filter exhaust air from the 105-B Reactor building prior to routing it to the 116-B Exhaust Stack. The exhaust air was routed to the filter building via an underground concrete inlet duct, filtered through high-efficiency particulate air (HEPA) and activated charcoal filters, and then routed to the stack via an underground exhaust duct. The Filter Building was reinforced concrete that was approximately 18 m (59 ft) long, 11.9 m (39 ft) wide, and 10.7 m (35 ft) high; 95% was below grade. The concrete walls and floors ranged from 20.3 cm (8 in.) thick to a maximum thickness of 30.5 cm (12 in.).

The 117-B Filter Building and associated below-grade ductwork were demolished in two phases beginning in March 1985 and continuing through January 1988. Phase I included work necessary prior to demolition activities and included extensive radiological surveying and sampling, the removal of assorted equipment (e.g., HEPA filters) for disposal in the 200 West Area Burial Grounds, and decontamination and/or fixing contamination.

4.55.2 Investigation

As part of Phase I activities, ARCL calculations were used to evaluate the potential radiological dose to a hypothetical, maximally exposed site resident if the site were released for unrestricted use after the demolition and burial in situ of the facility. The ARCL calculations were prepared in accordance with *Allowable Residual Contamination Levels for Decommissioning Facilities in the 100 Areas of the Hanford Site* (UNI 1983) and authorized by DOE-RL. The radionuclide inventories in the 117-B Filter Building and the inlet/outlet ducts were determined from radiological surveys, isotopic analyses, and from previously collected data (UNI 1978).

Based upon a review of the historical data and facility information, no additional sampling was necessary to confirm the radiological status of this site. Consistent with what would be expected, the historical radiological survey and sampling data indicate that the majority of the contamination for the 117-B Filter Building and inlet/outlet ducts was found upstream of the filter cells. The highest level of contamination was found on the floor of the "A" inlet cell which is approximately 4.9 m (16 ft) below grade and the floor of the "A" inlet seal pit, located approximately 7 m (23 ft) below grade. This residual contamination is below 4.6 m (15 ft) and does not present a direct exposure risk. The contamination exists in a thin paint layer and is not present in the concrete.

RESRAD evaluation using the historical paint data as a conservative approach predicts that carbon-14 and tritium from the paint in the 132-B-4, 117-B Filter Building will reach groundwater within 1,000 years at concentrations below the maximum contaminant levels. The evaluation predicts that the dose limits for the groundwater pathway (4 mrem/yr) will not be exceeded.

4.55.3 Statement of Protectiveness

The basis for reclassification of this site as "No Action" is described in detail in the calculation brief for the 132-B-4, 117-B Filter Building. The results of this calculation confirm that the 132-B-4 waste site achieves the RAOs and corresponding RAGs established in the interim action ROD. Any residual concentrations will support future land uses that can be represented (or bounded) by a rural-residential scenario and that, based on RESRAD modeling and ARCL evaluation, pose no threat to groundwater or the Columbia River.

4.56 132-B-5, 115-B/C GAS RECIRCULATION FACILITY

4.56.1 History

The 115-B/C Gas Recirculation Facility was in operation from 1952 until 1969. Although it was originally constructed for the 105-B Reactor, the 115-B/C Gas Recirculation Facility serviced the 105-C Reactor. The facility filtered and recirculated the inert gas that surrounded the core of the reactors. The recirculation cycle included cooling, drying, and filtering of the gas in large volumes prior to reentry into the reactor. The facility was decommissioned and demolished in two phases. Phase I included extensive radiological characterization, removal of process equipment and waste, and decontamination. The Phase II demolition and grading were performed using conventional heavy equipment and completed in 1989. The above-grade structure was demolished and removed for disposal in the area landfill. The at- and below-grade structure was demolished to at least 1 m (3 ft) below grade, and the resulting rubble was placed in the basement for in situ disposal. The area was backfilled to grade with clean fill material from a nearby borrow pit at the Hanford Site. The demolished facility is identified as the 132-B-5 waste site in WIDS.

4.56.2 Investigation

As part of the Phase I activities, ARCL calculations were used to evaluate the potential radiological dose to a hypothetical, maximally exposed site resident, if the site was released for unrestricted use after the demolition and in situ burial. The ARCL calculation results indicated that the facility was ready for demolition activities.

Using the greatest activities from the characterization data to represent residual contamination levels over 100% of the inner surface area of the former facility, RESRAD modeling was performed in 2003 to support the previous decision to demolish and bury the facility in place. The RESRAD modeling accounts for radioactive decay from 1989 (the year of demolition) to 2003 and predicts that the site achieves dose limits and risk objectives for rural-residential land use, groundwater protection, and river protection.

4.56.3 Statement of Protectiveness

The results of the investigation confirm that the 132-B-5 waste site achieves the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "No Action." Any residual concentrations will support future land uses that can be represented (or bounded) by a rural-residential scenario and that, based on RESRAD modeling and ARCL evaluation, pose no threat to groundwater or the Columbia River.

4.57 1607-B-1 SEPTIC TANK SYSTEM

4.57.1 History

The 1607-B1 Septic Tank System was located north of the 1720-B Building. It included a septic tank, drain field, and associated connecting pipelines and influent sanitary sewer lines. The system serviced the former 1701-B Badgehouse, 1720-B Patrol Building and 1709-B Fire Headquarters. The septic tank was constructed of reinforced concrete and has a 125-person capacity (132 L [35 gal] per capita) with an average detention period of 24 hours. The walls and floor are 25 cm (10 in.) thick. The tile field was constructed of 10-cm (4-in.) vitrified pipe, concrete pipe, or drain tile with a minimum of 2.4 m (8 ft) per capita. Unknown amounts of sanitary sewage were received at 1607-B-1.

4.57.2 Investigation

Excavation and confirmatory sampling at the 1607-B1 waste site was conducted on May 21, 2007. Excavation began with a test pit at the suspected location of the septic tank. The septic tank was encountered less than 0.3 m (1 ft) below ground surface and continued to the bottom of the tank, which was reached at 3.4 m (11 ft) below ground surface. Since the tank was backfilled, a single sample was collected of the contents from the bottom of the tank. Excavation continued at the south exterior wall of the septic tank where the inlet pipe (influent) to the tank was located. This pipe was located approximately 0.5 m (1.5 ft) below ground surface and found to be concrete-encased vitrified clay pipe (VCP). It was breached and found empty; therefore, a sample was collected from the soil underlying this pipe. Excavation then moved to the exterior north wall (effluent side) of the septic tank and continued to a depth of 3.7 m (12 ft) below ground surface, where the bottom of the tank was reached, and a sample was collected from the underlying soil. This excavation activity exposed the entire north wall of the tank, and two effluent pipes were revealed exiting this wall. Excavation continued toward the drain field by trenching along the deeper 20 cm (8 in.) diameter VCP until the drain field was reached. The pipe was empty; therefore an underlying soil sample was collected in accordance with the sample design. After sample collection was complete, the excavation was backfilled to grade.

4.57.3 Statement of Protectiveness

The results of the investigation confirm that the 1607-B-1 waste site achieves the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as

“No Action.” Any residual concentrations will support future land uses that can be represented (or bounded) by a rural-residential scenario and pose no threat to groundwater or the Columbia River.

4.58 1607-B2 SEPTIC TANK SYSTEM

4.58.1 History

The 1607-B2 Septic Tank System provided service to the 105-B, 108-B, 115-B/C, 185/190-B, and various 1700-B-Series Buildings. The waste site was subdivided into 1607-B2:1 (Septic Drainfield) and 1607-B2:2 (Septic Tank and Pipeline) to simplify verification sampling. The septic tank was located 390 m (1,280 ft) north of the 105-B Reactor building, and the drain field was located 240 m (787 ft) northwest of the septic tank. Confirmatory sampling was conducted in 2005. Multiple chemical and radiological contaminants were detected above action levels, prompting the remedial action decision.

4.58.2 Excavation Operations

Remediation of the 1607-B2 waste site was performed in stages (along with 100-B-14:2) from January 2005 through June 2006 as part of the 100-BC Area remaining pipes and sewers remediation project. Site remediation consisted of the removal of the sewer piping, septic tank, and drain field, as well as adjacent, potentially-contaminated soils for disposal to the ERDF. Due to its proximity to the 105-B Reactor building, the southernmost portion of the 1607-B2 pipeline was not removed. This portion of the pipeline will be addressed in the 118-B-8:3, 105-B Reactor waste site miscellaneous pipeline segments. Approximately 37,607 metric tons (41,455 US tons) of material was removed and disposed of at ERDF.

4.58.3 Verification Sampling

Cleanup verification sampling for the 1607-B2 waste site was concluded from August 2005 to July 2006 as part of the 100-B-14:2 cleanup verification. Additional details on the cleanup verification sampling are provided in Section 4.10.

4.58.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 1607-B2 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as “Interim Closed Out.” Residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils. The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. Site contamination did not extend into the deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

4.59 1607-B3 SEPTIC TANK SYSTEM**4.59.1 History**

The site consisted of a septic tank, tile field, and associated piping, which served the 184-B Powerhouse from 1944 to 1974. The septic tank was demolished in situ in early 1988, with remaining contents disposed at the 124-N-10 sanitary sewer system. Holes were punched in the bottom of the tank, and it was partially backfilled then compacted and graded.

4.59.2 Confirmatory Sampling

Prior to demolition, the contents of the tank were sampled. No significant radioactivity was found above background and there were no reportable concentrations of heavy metals.

4.59.3 Statement of Protectiveness

The sample results are consistent with a site reclassification of "Closed Out." No institutional controls are required for this site to prevent uncontrolled drilling or excavation into the deep zone.

4.60 1607-B4 SEPTIC TANK SYSTEM**4.60.1 History**

The site consisted of a septic tank, tile field, and associated piping which served the 151-B Substation from 1944 to 2000. The septic tank was demolished in situ in 2000, with remaining contents pumped out and the tank backfilled with clean material.

4.60.2 Confirmatory Sampling

Prior to demolition, the contents of the tank were sampled. No significant radioactivity was found above background and there were no reportable concentrations of heavy metals.

4.60.3 Statement of Protectiveness

The sample results are consistent with a site reclassification of "Closed Out." No institutional controls are required for this site to prevent uncontrolled drilling or excavation into the deep zone.

4.61 1607-B7 SEPTIC TANK SYSTEM

4.61.1 History

The 1607-B7 waste site was located north of the former 183-B Water Treatment Facility, about 400 m (1,300 ft) to the northwest of the 105-B Reactor building. The waste site consisted of a septic tank and drain field and was used for disposal of sanitary sewage from the 183-B Water Treatment Facility from 1944 until 1969. The tank was constructed of reinforced concrete with a brick manhole access. The 12-person capacity septic tank was buried at a depth of 2.5 m (8 ft). The drain field was constructed of 10-cm (4-in.) vitrified pipe, concrete pipe, or drain tile with a minimum of 2.4-m (8-ft) pipe length per capita. The pipe laterals were open-jointed and spaced about 2.4 m (8 ft) apart. The drain field was located due west of the tank. The inlet pipe from the 183-B Water Treatment Facility to the 1607-B7 waste site has been included in the 100-B-14 pipelines site.

4.61.2 Excavation Operations

Remedial action at the 1607-B7 waste site was conducted in March 2003. Excavation of the site involved removing overburden materials, septic system (tank and drain field), and underlying contaminated soil. Contaminated materials including the septic tank and drain field piping were disposed of at ERDF. Overburden soil was stockpiled adjacent to the site. Field screening indicated that overburden was clean. The excavation had an approximate area of 369 m² (3,970 ft²) and a depth of approximately 3.5 m (11.5 ft). Approximately 198 metric tons (218 US tons) of material from the site were disposed of at ERDF.

The 1607-B7 septic system inlet pipe was removed to the extent of the 1607-B7 waste site excavation. The remainder of the pipeline between the 183-B Water Treatment Facility and the 1607-B7 waste site has been included in the 100-B-14 pipelines site and was dispositioned with the other pipelines in that site.

4.61.3 Verification Sampling

Cleanup verification samples were collected on March 27, 2003, and consisted of composite samples formed by combining soil collected at four randomly selected nodes within each sampling area. The 1607-B7 waste site consisted of one shallow zone decision unit that was divided into four sampling areas. One composite cleanup verification sample was collected from each sample area.

4.61.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 1607-B7 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." The materials from the 1607-B7 waste site containing COCs at concentrations exceeding RAGs have been excavated and disposed of at ERDF. These results also indicate that residual concentrations will support future land uses that can be

represented (or bounded) by a rural-residential scenario, and that residual concentrations throughout the site do not pose a threat to groundwater or the Columbia River.

4.62 116-C-1, 107-C LIQUID WASTE DISPOSAL TRENCH

4.62.1 History

The 116-C-1 Trench was constructed in 1952 and is located northeast of the 116-C-5 Retention Basin. The 167-m long, 32-m wide, 5-m deep (548-ft long, 105-ft wide, 16.4-ft deep) site was a former unlined process effluent disposal trench that received 700 million L (184 million gal) of contaminated cooling water from the 100-BC Area Retention Basins after ruptured fuel elements were detected in the reactors (DOE/RL-93-06). The 116-C-1 waste site continued to receive contaminated cooling water until reactor operations ceased in 1968. An additional 40 billion L (more than 10 billion gal) of high-temperature reactor cooling water was discharged to the site during a 150-day infiltration test in 1967. This release likely influenced the distribution of contaminants beneath the site.

Influent water was transferred to the trench via two 107-cm (42-in.) steel pipes leading from the 168-cm (66-in.) outfall pipelines that lead from the 116-C-5 Retention Basins to the river. Two additional 6-cm (24-in.) pipes discharged influent water to the site. The contaminated water discharges to the soils continued from 1952 to 1968. After operations ceased in 1968, the site was decommissioned which included the placement of at least 1.5 m (4.9 ft) of fill material (shielding) over the entire base of the trench to stabilize the exposed contaminated surfaces of the engineered structure.

4.62.2 Excavation Operations

The final remediation efforts at the 116-C-1 waste site occurred in three separate stages: (1) excavation and disposal of the engineered structure, (2) excavation and disposal of the eight contaminated soil plume areas, and (3) characterization test pit excavation.

The excavation and disposal of the engineered structure began on July 15, 1996, and was completed on November 15, 1996. Eight contaminated soil areas extending beyond the engineered structure were identified during the subsequent field screening and sampling efforts. The excavation and disposal of the plume areas began on April 23, 1997, and were completed on October 28, 1997. After the soil plume excavation was completed, a test pit was excavated down to groundwater to further characterize the subsurface. The test pit was centered at an area of elevated activity (identified by radionuclide field surveys) near the 116-C-1 inlet pipes. The test pit effort began on December 15, 1997, and was completed on January 15, 1998.

At the completion of the remedial action, the excavation footprint was approximately 11,116 m² (119,608 ft²) at a depth of 5 m (16.4 ft) and an elevation of 128 m (420 ft). Approximately 97,515 metric tons (107,514 US tons) of site material were removed and disposed of at ERDF.

Construction Activity Summary

The entire engineered structure was removed. Influent pipelines on the west end of the site were remediated under a separate action.

4.62.3 Verification Sampling

Final cleanup verification sampling was conducted in December 1996. Each verification sample was a composite formed by combining samples collected at four randomly selected nodes within each sampling area.

Verification sampling of the 116-C-1 Process Effluent Trench was conducted in shallow zone, deep zone, and overburden decision units. The site was excavated to a maximum depth of approximately 5 m (16.4 ft), with the shallow zone consisting of the entire excavation sidewalls to the final depth of 5 m (16.4 ft). The deep zone consisted of the excavation floor, 5 m (16.4 ft) below surface grade.

4.62.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 116-C-1 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." Materials that contain COCs at concentrations that exceed the RAGs have been excavated, sampled, analyzed, and where required, the materials were removed and shipped to ERDF. The remaining soil has been sampled, analyzed, and evaluated to show that no residual COC concentrations in vadose zone soils pose an unacceptable threat to human health, groundwater, or the Columbia River. The acceptability of unrestricted direct exposure to deep zone soils has not been demonstrated; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are required.

4.63 116-C-5 RETENTION BASINS

4.63.1 History

The 116-C-5 Retention Basins site was located 1,040 m (3,400 ft) north of the 105-C Reactor and south of the 116-B-11 Retention Basin. The 116-C-5 Retention Basins received reactor cooling water from 1952 until 1969. After 1954, the effluent from the 105-B Reactor was diverted to the 116-C-5 Retention Basins since the 116-B-11 Retention Basin had cracked and repair efforts were unsuccessful. The retention basins were two circular, 38 million L (10 million gal) open-topped, above-ground tanks. Each tank had a diameter of 100 m (330 ft), a depth of 4.9 m (16 ft), and had internal baffles to prevent water from channeling across the tanks into the discharge lines. The tanks were constructed of welded carbon steel and were set on a reinforced concrete foundation with a crushed rock subfloor. Originally, only one tank was filled at a time, allowing the option for cooling water contaminated by a ruptured fuel element to be diverted to the second tank. The practice of adding hot water to an empty, cold tank resulted in cracking of the tank's welded seams. After a series of repair efforts extending into 1958,

parallel operation of the tanks became common. After use, the site was partially demolished and stabilized with soil.

4.63.2 Excavation Operations

Excavation of the 116-C-5 Retention Basins began on September 21, 1996, by removing the overburden materials and underlying contaminated soil. Based on field screening, overburden materials that were identified as potentially clean were placed in stockpiles for potential use as backfill. Overburden materials that were found to be contaminated were disposed of at ERDF. The excavation was completed on March 21, 1998.

Contaminated soil associated with the process effluent pipelines was partially removed; the rest remained for final remediation with the pipelines. The 116-C-5 sidewall areas that are adjacent to future pipeline excavation areas were not sampled as part of this cleanup verification effort. These areas were sampled and verified clean as part of the effluent pipeline remediation efforts.

At the completion of the remedial action, the excavation area floor was approximately 26,000 m² (280,000 ft²) at a depth of 4.6 m (15 ft). Approximately 224,709 metric tons (247,695 US tons) of material from the site were disposed of at ERDF.

4.63.3 Verification Sampling

Cleanup verification sampling began on August 18, 1998, and was finished on January 20, 1999.

Each verification sample was a composite formed by combining samples collected at four randomly selected nodes within each sampling area.

Verification sampling of the 116-C-5 Retention Basins was conducted in shallow zone, deep zone, and overburden decision units. The site was excavated to a maximum depth of approximately 4.6 m (15 ft), with the shallow zone consisting of the entire excavation sidewalls to the final depth of 4.6 m (15 ft). The deep zone consisted of the excavation floor, 4.6 m (15 ft) below surface grade.

Initial hexavalent chromium results for deep zone soil samples showed six composite samples exceeded RAGs. These areas were further excavated 1.1 m (3.6 ft) in depth and resampled for hexavalent chromium only. The second round of sampling showed all hexavalent chromium results were below RAGs.

4.63.4 Statement of Protectiveness

The verification sampling results demonstrate that remedial actions at the 116-C-5 waste site have achieved the RAOs and corresponding RAGs established in the interim action ROD and has been reclassified as "Interim Closed Out." Materials that contain COCs at concentrations that exceed the RAGs have been excavated, sampled, analyzed, and where required, the materials were removed and shipped to ERDF. The remaining soil has been sampled, analyzed, and

evaluated to show that no residual COC concentrations in vadose zone soils pose a threat to human health, groundwater, or the Columbia River. The acceptability of unrestricted direct exposure to deep zone soils has not been demonstrated; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are required.

4.64 600-34, 100-B BALED TUMBLEWEED DISPOSAL SITE

This former borrow pit contains baled tumbleweeds and miscellaneous pre-Hanford farm debris. No evidence exists to indicate hazardous, dangerous, or radioactive wastes were disposed at this site. No distressed vegetation, discolored soil, or other evidence of hazardous or dangerous waste disposal was found. The site was therefore classified as "Rejected."

4.65 600-56, PRE-HANFORD FARM SITE

The site contains abandoned waste from pre-Hanford residential activities. No evidence exists to indicate hazardous, dangerous, or radioactive waste was disposed at this site. No distressed vegetation, discolored soil, or other evidence of hazardous or dangerous waste disposal was found. The site was therefore classified as "Rejected."

4.66 600-67, BRUGGEMANN'S FRUIT STORAGE WAREHOUSE

This is an abandoned pre-Hanford structure, including a small adjacent underground fuel storage tank and miscellaneous debris. There were no known releases from the tank, and areas surrounding the tank show no soil staining or stressed vegetation. The structure is undergoing the process for listing on the National Register of Historic Places, and has been classified as "Rejected."

4.67 600-230, RCRA GENERAL INSPECTION 200WFY97 ITEM #4 HISTORIC DISPOSAL SITE

This is a pre-Hanford residential dump site, containing various colored glass fragments, broken china, an enamel ware cook pot, and various cans, buckets, and other containers. The site has been classified as "No Action."

4.68 600-231, RCRA GENERAL INSPECTION 200WFY97 ITEM #5 HISTORIC DISPOSAL SITE

This is a pre-Hanford residential dump site located near the Columbia River. It contains food cans, paint containers, buckets, glass, concrete, and a rubber tire. It has been classified as "Not Accepted."

4.69 600-253, GRAVEL PIT #24

Located just northwest of the 100-BC Area, this large excavated area is actively used as a source of gravel and sand. There is no evidence of hazardous or radioactive wastes disposed at this site, and it has been classified as "Not Accepted."

4.70 600-264, ABANDONED OIL DRUM

This site originally consisted of a 55-gal drum surrounded by orchard smudge pots, and oil-stained soil. Analytical sample results from the oil showed no PCBs or radionuclides, low metals, slightly elevated volatiles, and elevated total petroleum hydrocarbons. The drum and the oil-stained soil were removed, and the site classified as "Rejected."

5.0 PERFORMANCE STANDARDS AND CONSTRUCTION QUALITY CONTROL

This section addresses the process for demonstrating achievement of performance standards including attainment of RAGs and maintaining the required quality controls during remedial activities.

5.1 ATTAINMENT OF PERFORMANCE STANDARDS

The remedial actions described in Sections 4.1 through 4.7 of this report were performed to identify and reduce potential threats to human health and the environment from 100-BC-1 OU waste site contamination. Following remediation activities at a waste site, an evaluation against identified performance standards (the RAOs in the interim action RODs) is conducted to verify that the residual contamination does not pose an unacceptable health risk to future users of the site.

5.1.1 Performance Standard Documentation

Attainment of the specific RAO performance standards in the interim action RODs and interim closure of individual 100-BC-1 OU waste sites are documented in the cleanup verification packages (CVPs), or remaining sites verification packages (RSVPs). These documents provide remediation information as described in Section 2.3 to support the formal reclassification in the WSRFs listed in Table 5-1. The RSVP documents address the waste sites that are identified in the "remaining sites interim action RODs," and the CVPs address the waste sites identified in the other interim action RODs listed in Section 2.1.

Table 5-1. Summary of 100-BC-1 Operating Unit Closure Documentation. (4 Pages)

WIDS Site Code	CVP Document Number	Document Name	WSRF Number	WIDS Site Reclassification Status
100-B-2	--	--	2004-101	No Action
100-B-3	--	--	2003-008	No Action
100-B-4	--	--	--	Not Accepted
100-B-5	2003-00014	CVP for the 100-B-5 Effluent Vent Disposal Trench	2003-030	Interim Closed Out
100-B-7	--	--	--	Not Accepted
100-B-8:1	2003-00022	CVP for the 100-B-8:1 and 100-C-6:1, 100-B/C South Effluent Pipelines	2004-020	Interim Closed Out
100-B-8:2	2003-00019	CVP for the 100-B-8:2, 100-C-6:2, 100-C-6:3, and 100-C-6:4, 100-B/C North Effluent Pipelines	2003-050	Interim Closed Out
100-B-10	--	--	2001-021	No Action
100-B-11	--	RSVP for 100-B-11, 115-B/C Caisson, Sump, Drywell, Tank, and Caisson Valve Pit Site	2004-003	No Action

Table 5-1. Summary of 100-BC-1 Operating Unit Closure Documentation. (4 Pages)

WIDS Site Code	CVP Document Number	Document Name	WSRF Number	WIDS Site Reclassification Status
100-B-12	--	RSVP for 100-B-12 Filter Box Storage	2001-016	Interim Closed Out
100-B-14:1	--	RSVP for the 100-B-14:1 Process Sewer	2004-005	Interim Closed Out
100-B-14:2	--	RSVP for the 1607-B2 Septic System and the 100-B-14:2 Sanitary System	2004-006	Interim Closed Out
100-B-14:3	--	RSVP for 100-B-14:3 West Process Sewer Pipelines Site	2004-007	No Action
100-B-14:4	--	--	2004-008	No Action
100-B-14:5	--	RSVP for 100-B-14.5 Sodium Dichromate and Sodium Silicate Lines	2004-009	No Action
100-B-14:6	--	RSVP for 100-B-14:6, 184-B Powerhouse Pipelines Site	2004-010	No Action
100-B-14:7	--	RSVP for 100-B-14:7, 185-B/190-B Sump and Pipelines Site	2004-011	No Action
100-B-16	--	RSVP for the 100-B-16 Utility Poles and Fixtures Debris Pile	2005-009	Interim Closed Out
100-B-17	--	--	2010-011	Rejected
100-B-18	--	RSVP for the 100-B-18, 184-B Powerhouse Debris Pile	2007-020	Interim Closed Out
100-B-19	--	RSVP for the 100-B-19, 100-B/C Stained Soil Sites and 100-B/C Chemical Contaminated Surface Soil Areas	2009-051	Interim Closed Out
100-B-20	--	RSVP for the 100-B-20, 1716-B Maintenance Garage Underground Tank	2006-019	Interim Closed Out
100-B-21:1	--	RSVP for the 100-B-21:1 Subsite (100-B/C Miscellaneous Pipelines, DS-100BC-016, and DS-100BC-022)	2005-052	No Action
100-B-21:2	--	RSVP for the 100-B-21:2 Subsite (100-B/C Discovery Pipeline, DS-100BC-002)	2008-003	Interim Closed Out
100-B-21:3	--	--	2008-052	Interim Closed Out
100-B-21:4	--	RSVP for the 100-B-21:4 Pipeline From the 105-C Reactor to the 116-C-2B Sump	2009-041	Interim Closed Out
100-B-22:1	--	RSVP for the 100-B-22:1 Pipelines and Associated Soils	2005-042	No Action
100-B-22:2	--	RSVP for the 100-B-22:2, 100-B Water Treatment Facilities	2010-004	Interim Closed Out
100-B-24	--	RSVP for the 100-B-24 Spillway	2006-051	No Action
100-B-25	--	RSVP for the 100-B-25 Overflow Spillway (132-B-6 Outfall)	2009-034	Interim Closed Out
100-B-26	--	RSVP for the 100-B-26 Spillway	2006-052	No Action
100-B-27	--	RSVP for the 100-B-27 Sodium Dichromate Spill	2009-040	Interim Closed Out
100-B-28	--	RSVP for the 100-B-28, 183-C Headhouse to the 183-B Pumphouse Sodium Dichromate Transfer Pipeline	2009-057	Interim Closed Out
100-B-29	--	--	--	Not Accepted
100-B-32	--	RSVP for the 100-B-32 Soil Contamination Area Associated with Legacy Waste, SCA#1	2009-053	Interim Closed Out

Table 5-1. Summary of 100-BC-1 Operating Unit Closure Documentation. (4 Pages)

WIDS Site Code	CVP Document Number	Document Name	WSRF Number	WIDS Site Reclassification Status
100-B-33	--	RSVP for the 100-B-33, Soil Contamination Area 2 Associated with Legacy Waste	2009-043	Interim Closed Out
116-B-1	99-00012	CVP for the 116-B-1 Process Effluent Trench	99-048	Interim Closed Out
116-B-2	99-00015	CVP for the 116-B-2 Fuel Storage Basin Trench	99-097	Interim Closed Out
116-B-3	99-00013	CVP for the 116-B-3 Pluto Crib	99-101	Interim Closed Out
116-B-4	99-00014	CVP for the 116-B-4 French Drain	99-082	Interim Closed Out
116-B-5	--	--	98-064	Interim Closed Out
116-B-6A	99-00011	CVP for the 116-B-6A Crib and 116-B-16 Fuel Examination Tank	99-055	Interim Closed Out
116-B-6B	99-00017	CVP for the 116-B-6B Crib	99-096	Interim Closed Out
116-B-7	2002-00003	CVP for the 116-B-7, 132-B-6, and 132-C-2 B/C Outfalls	2002-046	Interim Closed Out
116-B-9	99-00009	CVP for the 116-B-9 French Drain	99-053	Interim Closed Out
116-B-10	99-00010	CVP for the 116-B-10 Dry Well/Quench Tank	99-054	Interim Closed Out
116-B-11	99-00001	CVP for the 116-B-11 Retention Basin	99-033	Interim Closed Out
116-B-12	99-00008	CVP for the 116-B-12 Seal Pit Crib	99-052	Interim Closed Out
116-B-13	99-00002	CVP for the 116-B-13 South Sludge Trench	99-034	Interim Closed Out
116-B-14	99-00003	CVP for the 116-B-14 North Sludge Tank	99-035	Interim Closed Out
116-B-15	--	--	2003-052	No Action
116-B-16	99-00011	CVP for the 116-B-6A Crib and 116-B-16 Fuel Examination Tank	99-055	Interim Closed Out
118-B-5	2004-00003	CVP for the 118-B-5 Burial Ground	2004-017	Interim Closed Out
118-B-7	--	--	2004-099	Rejected
118-B-9	--	RSVP for 118-B-9, 104-B-1 Tritium Vault and 105-B-2 Tritium Laboratory(104-B2 Storage Building) Site	2004-004	No Action
118-B-10	2004-00004	CVP for the 118-B-10 Burial Ground	2004-018	Interim Closed Out
120-B-1	--	RSVP for the 120-B-1, 105-B Battery Acid Sump	2006-057	Interim Closed Out
126-B-1	--	--	98-007	Rejected
126-B-2	--	RSVP for the 126-B-2, 183-B Clearwells	2007-004	No Action
126-B-3	--	RSVP for the 126-B-3, 184-B Coal Pit Dumping Area	2005-028	Interim Closed Out
126-B-4	--	--	97-008	Rejected
128-B-1	--	--	--	Not Accepted
128-B-2	--	RSVP for the 128-B-2, 100-B Burn Pit #2 Waste Site	2005-038	Interim Closed Out
128-B-3	--	RSVP for the 128-B-3 Burn Site	2006-058	Interim Closed Out
132-B-1	--	--	2003-044	No Action
132-B-3	--	--	2003-011	No Action
132-B-4	--	--	2003-010	No Action
132-B-5	--	--	2003-027	No Action
132-B-6	2002-00003	CVP for the 116-B-7, 132-B-6, and 132-C-2-B/C Outfalls	2002-046	Interim Closed Out
1607-B1	--	RSVP for 1607-B1 Septic Tank System	2007-015	No Action

Table 5-1. Summary of 100-BC-1 Operating Unit Closure Documentation. (4 Pages)

WIDS Site Code	CVP Document Number	Document Name	WSRF Number	WIDS Site Reclassification Status
1607-B2	--	RSVP for the 1607-B2 Septic System and the 100-B-14:2 Sanitary Sewer System	2006-055	Interim Closed Out
1607-B3	--	--	2001-015	Closed Out
1607-B4	--	--	2000-121	Closed Out
1607-B7	2003-00004	CVP for 1607-B7 Septic Tank System	2003-012	Interim Closed Out
116-C-1	98-00006	CVP for the 116-C-1 Process Effluent Trench	98-012	Interim Closed Out
116-C-5	99-00004	CVP for the 116-C-5 Retention Basin	99-036	Interim Closed Out
132-C-2	2002-00003	CVP for the 116-B-7, 132-B-6, and 132-C-2-B/C Outfalls	2002-046	Interim Closed Out
600-34	--	--	97-010	Rejected
600-56	--	--	97-009	Rejected
600-67	--	--	2000-125	Rejected
600-230	--	--	2006-041	No Action
600-231	--	--	--	Not Accepted
600-253	--	--	--	Not Accepted
600-264	--	--	2000-124	Rejected

CVP = cleanup verification package
 RSVP = remaining sites verification package
 WIDS = Waste Information Data System
 WSRF = waste site reclassification form

5.1.2 Remedial Action Objectives and Goals

Remedial action objective performance standard attainment involves comparisons of soil analytical data to RAGs (Table 5-2) and is evaluated using the following general steps:

- Identify the units within a site for cleanup verification and conduct sample collection and analysis for COCs and COPCs
- Calculate the summary statistics for the identified units or maximum values
- Identify the appropriate RAGs to be applied to the units
- Evaluate the summary statistics or maximum values, as appropriate, for the identified units against the decision rules for achieving the appropriate RAGs.

Remedial action goals are specific numeric targets developed to ensure achievement of the RAOs identified in the interim action RODs. The RAGs applicable to the 100-BC-1 waste sites, along with the process for verifying attainment of the RAGS, are described in detail in the 100 Area RDR/RAWP (DOE/RL-96-17) and are summarized in Table 5-2.

**Table 5-2. Summary of Achieved Performance Standards
for Unrestricted Land Use.**

Regulatory Requirement	Remedial Action Goals	Evaluation Method
Direct Exposure – Radionuclides	Attained <15 mrem/yr dose rate above background over 1,000 years. Attained the CERCLA risk range of 10^{-4} to 10^{-6} .	Compared dose and risk goals to RESRAD model outputs based on unrestricted land use assumptions and verification data set values.
Direct Exposure – Nonradionuclides	Attained individual COC RAGs (MTCA Method B cleanup levels for unrestricted land use). Pass the WAC 173-340-740(7)(e) three-part test.	Compared goals with verification data set values.
Risk – Nonradionuclides	Achieved hazard quotient of <1 for noncarcinogens.	Compared goal with individual hazard quotients calculated from verification data set values.
	Achieved cumulative hazard quotient of <1 for noncarcinogens.	Compared goal with cumulative hazard quotients calculated from verification data set values.
	Achieved excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	Compared goal with individual carcinogen risks calculated from verification data set values.
	Attained a cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.	Compared goal with cumulative carcinogen risks calculated from verification data set values.
Groundwater/River Protection – Radionuclides	Attained individual radionuclide groundwater and river cleanup requirements. Attained National Primary Drinking Water Standards <4 mrem/yr (beta/gamma) dose rate.	Compared goals to RESRAD model outputs based on unrestricted land-use assumptions and verification data set values.
Groundwater/River Protection – Nonradionuclides	Attained individual nonradionuclide groundwater and river cleanup requirements.	Compared goals to MTCA WAC 173-340-720; 173-340-730; and 173-201A.

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*

COC = contaminant of concern

MTCA = *Model Toxic Control Act*

RAG = remedial action goal

RESRAD = RESidual RADioactivity

WAC = *Washington Administrative Code*

5.1.3 Contaminant Identification

The COPCs and COCs for some waste sites were initially identified in the interim action RODs based on historical and field investigation information, and were further refined during development of the 100 Area RDR/RAWP (DOE/RL-96-17), sampling and analysis plan documents (DOE/RL-96-22, *100 Area Remedial Action Sampling and Analysis Plan*), and the 100 Area Burial Grounds SAP (DOE/RL-2001-35). The final lists of relevant contaminants of concern are documented in the CVP or RSVP for each waste site to reflect additional constituents identified during the remediation and characterization process (Table 5-3), pursuant to the interim action ROD "observational approach." Following the process described in this section, residual soil concentrations at all of the sites addressed in this report were shown to meet the RAO performance standards established for unrestricted surface use. The waste sites individually meet the cleanup objectives for eventual unrestricted surface use summarized in Table 5-2. Closeout of individual waste sites was based on the evaluation of analytical laboratory results from verification or confirmatory soil samples that were analyzed by contract laboratories using approved EPA methods. The resulting data for each waste site were subjected to a data quality assessment and determined to be suitable for their intended use to support closure decisions.

Table 5-3. Summary of Waste Site Contaminants of Concern, and Contaminants of Potential Concern. (2 Pages).

100-BC-1 Operable Unit																																																				
COCs	100-B-5	100-B-8:1	100-B-8:2	100-B-12	100-B-14:1	100-B-14:2	100-B-16	100-B-18	100-B-19	100-B-20	100-B-21:1	100-B-21:2	100-B-21:3	100-B-22:1	100-B-25	100-B-27	100-B-28	100-B-32	100-B-33	116-B-1	116-B-2	116-B-3	116-B-4	116-B-5	116-B-6A	116-B-6B	116-B-7	116-B-9	116-B-10	116-B-11	116-B-12	116-B-13	116-B-14	116-B-16	118-B-5	118-B-10	120-B-1	126-B-3	128-B-2	128-B-3	132-B-6	1607-B2:1	1607-B2:2	1607-B-3	1607-B-4	1607-B7	116-C-1	116-C-5	132-C-2			
Radionuclides																																																				
Americium-241	X	X	X			X		X			X	X	X		X			X		X							X				X		X	X							X		X				X	X	X	X		
Carbon-14					X														X																	X																
Cesium-137	X	X	X		X	X		X			X	X	X		X			X	X	X	X	X	X	X	X		X	X	X	X		X	X	X							X		X			X	X	X	X			
Cobalt-60	X	X	X		X	X		X			X	X	X		X			X	X	X			X	X	X		X	X	X	X		X	X	X	X	X	X					X		X			X	X	X	X		
Europium-152	X	X	X		X	X		X			X	X	X		X			X	X	X	X		X	X	X		X	X	X	X		X	X	X							X		X			X	X	X	X			
Europium-154	X	X	X		X	X		X			X	X	X		X			X	X	X	X		X	X	X		X		X	X		X	X	X							X		X			X	X	X	X			
Europium-155	X	X	X		X	X		X			X	X	X		X			X	X				X				X			X		X	X								X		X			X	X	X	X			
Gross alpha/beta						X		X				X						X																																		
Nickel-63			P												X				X	X							X				X					X	X					X					X	X	X			
Plutonium-238	X	X	X												X				X	X							X				X		X	X								X					X	X	X			
Plutonium-239/240	X	X	X																X	X			X				X				X		X	X								X					X	X	X			
Strontium-90	X	X	X			X									X				X	X	X	X			X		X	X	X	X	X	X	X	X	X							X		X			X	X	X			
Tritium					X	X													X					X			X																X		X					X		
Uranium-233/234															X				X		X	X				X		X		X					X							X								X		
Uranium-235															X				X								X															X								X		
Uranium-238	X	X	X												X				X	X	X					X		X		X	X	X	X	X	X					X							X	X	X			
Inorganics																																																				
Asbestos							X					X		X																																						
ICP metals	X	X	X			X	X	X	X	X	X	X	X		X	X	X		X	X					X		X	X			X		X	X					X	X	X	X	X	X	X			X	X	X	X	
Hexavalent chromium	X	X	X		X	X			X			X	X		X	X	X			X	X	X			X		X			X	X	X	X	X	X					X	X		X	X	X	X			X	X	X	
Mercury	X	X	X			X	X	X	X	X	X		X		X	X	X							X	X		X			X	X		X	X	X					X	X	X	X	X	X	X				X	X	X
pH																																																				
Sulfide/sulfate																																																				
Organics																																																				
Herbicides																																																				
PAH								X										P																																		
Pesticides						X																																														
PCBs					X	X	X	X		X																																										
SVOCs					X	X	X			X		X	X																																							

Table 5-3. Summary of Waste Site Contaminants of Concern, and Contaminants of Potential Concern. (2 Pages).

100-BC-1 Operable Unit																																																	
COCs	100-B-5	100-B-8:1	100-B-8:2	100-B-12	100-B-14:1	100-B-14:2	100-B-16	100-B-18	100-B-19	100-B-20	100-B-21:1	100-B-21:2	100-B-21:3	100-B-22:1	100-B-25	100-B-27	100-B-28	100-B-32	100-B-33	116-B-1	116-B-2	116-B-3	116-B-4	116-B-5	116-B-6A	116-B-6B	116-B-7	116-B-9	116-B-10	116-B-11	116-B-12	116-B-13	116-B-14	116-B-16	118-B-5	118-B-10	120-B-1	126-B-3	128-B-2	128-B-3	132-B-6	1607-B2:1	1607-B2:2	1607-B-3	1607-B-4	1607-B7	116-C-1	116-C-5	132-C-2
TPH										X																												X	X	X									
VOCs								X																		X												X	X	X		X							

COC = contaminant of concern
ICP = inductively coupled plasma
P = discovery site within this waste site analyzed for this contaminant of potential concern
PAH = polycyclic aromatic hydrocarbons
PCB = polychlorinated biphenyl
SVOC = semivolatile organic compound
TPH = total petroleum hydrocarbons
VOC = volatile organic compound

5.2 FUTURE ATTAINMENT OF FINAL REMEDIAL ACTION PERFORMANCE STANDARDS

Cleanup of waste sites in accordance with the interim action RODs is expected to continue in the River Corridor until interim remedial action decisions are replaced by final RODs. Final RODs are required (40 *Code of Federal Regulations* 300) for the 100-BC Area in order to identify the final remedy decision, including any adjustments to the remedy identified in the interim action RODs, if necessary, to ensure protection of human health and the environment.

In addition to the information and data that originally established the basis for remedial actions under the interim action RODs, final remedial action decisions will incorporate new information acquired through characterization of interim closed waste sites. Development of the final remedy RODs will also incorporate data and information collected during the final source and groundwater remedial investigation and feasibility study. A key element of the RI/FS activities to support final RODs is a comprehensive human health and ecological baseline risk assessment. As discussed in Section 2.0 of this report, interim remedial actions are supported by streamlined qualitative risk assessments that establish a need to perform remedial actions. The River Corridor Baseline Risk Assessment results will be used to evaluate the protectiveness of current remedial actions and the development of cleanup levels in the final RODs.

The final ROD development process will also incorporate evaluation of emerging ecological protection requirements, although the interim action RODs included general objectives for protection of ecological receptors based on meeting the unrestricted land-use cleanup levels. In addition, exposure assumptions that formed the basis for development of the rural-residential exposure scenario will be evaluated and may be adjusted to reflect current applicable or relevant and appropriate requirements and land-use decisions. Finally, the basis for demonstrating that final remedial actions are protective of groundwater and the Columbia River will be updated according to current applicable or relevant and appropriate requirements.

The final RODs will integrate historical and current characterization information, as well as current applicable or relevant and appropriate requirements. Waste sites remediated under interim action RODs will ultimately be evaluated by the lead agency (DOE) and lead regulatory agency (EPA, for the 100-BC-1 OU) against the decisions and requirements documented in the final RODs. Upon satisfactory completion of the final remedial actions for the 100-BC-1 OU, EPA will issue a certificate of completion to DOE.

5.3 QUALITY CONTROL

The quality assurance and quality control programs used throughout the remediation activities are identified in the 100 Area RDR/RAWP (DOE/RL-96-17), the *100 Area Remedial Action Sampling and Analysis Plan* (DOE/RL-96-22), and the 100 Area Burial Grounds SAP (DOE/RL-2001-35). Samples that were used to demonstrate achieving the cleanup objectives for individual waste sites were collected and analyzed in accordance with these documents, which were approved by the Tri-Party agencies. The sampling and analysis plan documents contained

a quality assurance project plan to establish the objectives, functional activities, methods, and quality assurance/quality control measures associated with the sampling and analysis activities. Verification data sets that were used to support waste site closure underwent a data quality assessment to ensure suitability for their intended use. Results of the data quality assessment are documented in the CVPs and RSVPs for individual waste sites.

6.0 FINAL INSPECTION AND CERTIFICATIONS

Based on evaluation of the approved closeout documentation referenced in Table 5-1, interim remedial actions have been completed and RAOs have been achieved. Pursuant to the scope of the 100 Area RODs and RAOs, this means that contaminated soil was excavated and disposed at ERDF and waste sites were backfilled (as needed) and revegetated.

The results of confirmatory and verification sampling at interim closed out and no-action 100-BC-1 OU waste sites show that residual contaminant concentrations do not preclude future uses (as bounded by the rural-residential scenario) and allow for unrestricted surface use (i.e., ground surface to 4.6 m [15 ft] deep). The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. If deemed necessary, final inspections of the interim remedial actions will be conducted in the future and include the DOE-RL, EPA, and WCH representatives. The inspections would include only the waste sites where remedial actions occurred to verify that the sites had been backfilled with clean materials and revegetated as required by the applicable interim action RODs. The waste sites have been reclassified in WIDS as "Interim Closed Out," "No Action," or "Rejected" (RL-TPA-90-0001).

DOE/RL-2001-41, *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions*, describes institutional controls for the Hanford Site. Institutional controls are required at 24 of the remediated 100-BC-1 OU waste sites. Table 6-1 identifies each individual waste site and its associated institutional control. The primary institutional control associated with the waste sites is acceptability of unrestricted direct exposure to deep zone soils. Analyses of deep zone soils at these waste sites have been demonstrated not to meet cleanup levels for unrestricted direct exposure. Hence, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are required.

Table 6-1. 100-BC-1 Waste Site Specific Institutional Controls. (3 Pages)

WIDS Site Code	WIDS Site Name and Aliases	Institutional Control
100-B-5	Effluent Vent Disposal Trench, 116-B-9, 105-B Effluent Vent Trench	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
100-B-8	100-B Area Effluent Pipelines	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
100-B-8:1	100-B Area Effluent Pipelines	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
100-B-8:2	100-B Area Effluent Pipelines	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).

Table 6-1. 100-BC-1 Waste Site Specific Institutional Controls. (3 Pages)

WIDS Site Code	WIDS Site Name and Aliases	Institutional Control
100-B-14:1	100-B Area Process and Sanitary Sewer Underground Pipelines	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
100-B-21:4	100-BC Miscellaneous Pipelines	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
116-B-1	107-B Liquid Waste Disposal Trench, Process Effluent Trench	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
116-B-2	105-B Storage Basin Trench, B-Storage Basin Crib	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
116-B-3	105-B Pluto Crib	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
116-B-4	105-B Dummy Decontamination French Drain, 105-B Dummy Decontamination Disposal Crib	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
116-B-6A	111-B Crib No. 1, 116-B-6-1	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
116-B-7	1904-B-1 Outfall Structure	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
116-C-1	107-C Liquid Waste Disposal Trench	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
116-B-11	107-B Retention Basin	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
116-B-12	117-B Crib, 117-B Seal Pit Crib	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
116-B-16	111-B Fuel Examination Tank	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
116-C-5	116-C-5 Retention Basins, 107-C Retention Basins	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
128-B-3	100-B Dump Site, 128-B-3 Coal Ash and Demolition Waste Site, 128-B-3 Burning Pit Site, 600-57	Institutional controls are required to prevent activities that would mobilize residual contamination at the river embankment area. No institutional controls are required for the upland portions of the site.

Table 6-1. 100-BC-1 Waste Site Specific Institutional Controls. (3 Pages)

WIDS Site Code	WIDS Site Name and Aliases	Institutional Control
132-B-1	108-B Tritium Separation Facility	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
132-B-3	108-B Ventilation Exhaust Stack Site	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
132-B-4	117-B Filter Building	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
132-B-5	115-B/C Gas Recirculation Facility	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
132-B-6	1904-B-2 Outfall Structure Site	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).
132-C-2	1904-C Outfall, 116-C-4	Institutional controls are required to prevent uncontrolled drilling or excavation into deep zone (i.e., below 4.6 m [15 ft]).

WIDS = Waste Information Data System

The 128-B-3 waste site has the only institutional controls that do not apply to access to the deep zone. For this site the imposition of institutional controls on the river embankment area are required to prevent activities that would mobilize residual contaminants to travel to groundwater or the river.

The remaining remediated waste sites in the 100-BC-1 OU area are available for unrestricted land use.

7.0 OPERATIONS AND MAINTENANCE ACTIVITIES

There is no CERCLA site-specific surveillance and maintenance associated with the 100-BC-1 OU waste sites that have institutional controls. The DOE will retain responsibility for operations and maintenance functions of the 100-BC-1 OU area. These functions and associated landlord responsibilities cover all of the general infrastructure and include such things as access roads, facilities, and services. Monitoring at the Hanford Site is conducted in order to evaluate the performance of the remedies and to identify changes in conditions. In remediated areas, monitoring activities help to verify that the remedies remain effective, resources are protected, and that contaminant migration is prevented. Monitoring also helps to facilitate the maintenance of remedy systems in working condition and to keep controls in working order. These activities are often defined in an operations and maintenance plan for a site, such as maintaining signs, fences, and restrictions on excavations or land use.

The DOE will continue to be responsible for the following general activities:

- Responding to emergency situations or off-normal conditions such as the deterioration of a physical control beyond predicted levels, an error that results in a “near-miss,” or the discovery of previously unidentified sources of contamination.
- Notification of the appropriate regulatory agencies of regulatory threshold exceedances, releases of hazardous substances in excess of quantities reportable under CERCLA, and spills or discharges of hazardous substances or dangerous wastes to the environment.
- Long-term monitoring will be required for source sites where residual contaminants preclude unrestricted use.
- Surveillance and maintenance for the reactors in “interim safe storage.” Workers will enter the structure every 5 years to conduct inspections and make any needed repairs. Multiple resource management plans have been developed at the Hanford Site to protect and provide the policies, goals, and objectives for the management of the site’s biological, natural, and cultural resources. These plans address the ongoing surveillance, protection, and controlled use of the resources and guide the management of resources.

CERCLA 5-year reviews will be required to assess the protectiveness of remedial actions where hazardous substances, pollutants, or contaminants are left onsite above levels that allow for unlimited use and unrestricted exposure. In addition to CERCLA, the Tri-Party Agreement allows 5-year reviews to address regulated RCRA units and past-practice units that are regulated under RCRA and/or CERCLA. The DOE began the third CERCLA 5-year review report for the Hanford Site in 2010.

7.1 ENVIRONMENTAL MONITORING

The 100 Area of the Hanford Site includes significant natural resources including habitat for numerous endangered, protected, and listed species. In addition to the cleanup conducted under CERCLA, environmental monitoring and reporting on the 100-BC-1 OU is conducted annually in accordance with DOE O 231.1A, *Environment, Safety, and Health Reporting*. PNNL-19455, *Hanford Site Environmental Report for Calendar Year 2009*, includes a summary of cleanup performance and compliance relative to applicable federal, state, and local environmental laws and regulations; DOE orders; Secretary of Energy Notices; and DOE Headquarters and site operations office directives, policies, and guidance. It summarizes specific requirements, actions, plans, and schedules identified in the Tri-Party Agreement (Ecology et al. 1989) and other compliance or consent agreements. Although the report is written each year primarily to meet DOE reporting requirements and guidelines, it is also intended to provide a broad spectrum of environmental information to DOE managers, the public, the tribes, public officials, regulatory agencies, Hanford Site contractors, and elected representatives.

Each annual report provides an overview of activities at the site; demonstrates the status of the site's compliance with applicable federal, state, and local environmental laws and regulations, executive orders, and DOE policies and directives; and summarizes environmental data that characterize Hanford Site environmental management performance. The report also highlights significant environmental and public protection programs and efforts.

The monitoring includes many Hanford Site activities including decommissioning, demolition, remediation, restoration, waste management, closure activities, environmental occurrences, pollution prevention, waste minimization, and monitoring activities for environmental resources. Media included in the monitoring activities are air emissions, facility effluents, surface water, river sediment, drinking water, groundwater, food/farm products, vegetation, fish and wildlife (including threatened and endangered species), radiation, and cultural resources.

There are no site-specific CERCLA monitoring requirements associated with the 100-BC-1 OU waste sites.

7.2 GROUNDWATER MONITORING

Groundwater monitoring at the Hanford Site is guided by DOE/RL-2002-59, *Hanford Site Groundwater Strategy: Protection, Monitoring, and Remediation*, and fulfills requirements for monitoring according to the *Atomic Energy Act of 1954*, RCRA, CERCLA, and WAC 173-303. The strategy focuses on protecting groundwater, groundwater monitoring and groundwater remediation. Sampling and analysis in the 100-BC-5 OU, which is the groundwater beneath the 100-BC-1 OU is performed according to the *100-BC-5 Operable Unit Sampling and Analysis Plan* (DOE/RL-2003-38), and *Data Quality Objectives Summary Report - Designing a Groundwater Monitoring and Assessment Network for the 100-BC-5 and 100-FR-3 Operable Units* (PNNL-14287). Monitoring Results are presented in annual Hanford Site groundwater monitoring reports.

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Groundwater monitoring is performed in the 100-BC-5 OU by collecting samples from groundwater monitoring wells, and aquifer tubes and shoreline springs adjacent to the Columbia River samples. Contaminants routinely monitored are strontium-90, tritium, hexavalent chromium, and nitrate. Elevated levels of strontium-90, tritium, chromium, and nitrate are detected in operable unit groundwater. Elevated levels of strontium-90 and chromium were detected in aquifer tubes adjacent to the Columbia River. Groundwater remediation is not currently being performed in the 100-BC-5 OU.

8.0 PROJECT COST SUMMARY

This section presents a summary of the actual project costs associated with the remedial actions and backfill/revegetation operations performed between 1995 and 2010, as addressed in Section 4.0 of this report. All cost data are intended to represent the fully burdened cost for the work performed, including all applicable direct and indirect overhead charges. The total cost of work performed for the sites and activities addressed in this report was more than \$57.5 million (Table 8-1). The estimated ROM costs for remediation and confirmatory sampling was \$208.9 million. Unit rates for work performed (remedial action and waste disposal) ranged from \$23/US ton to \$867/US ton (Table 8-2). The following subsections present additional background, breakdown, and discussion of the project costs.

8.1 COST COLLECTION METHOD

All costs in the report for work performed under the RCCC were extracted from data accumulated and maintained in Deltek Cobra® program files. Cost data for work conducted prior to the RCCC under the Environmental Restoration Contract (ERC) was extracted from invalidated working files. A work breakdown structure (WBS) collection system was established early in the project planning process. Actual remedial action project costs were captured by WBS as presented in Figure 8-1. Unit rates for transportation/disposal and treatment (stabilization, macroencapsulation) were provided by ERDF based on its own WBS and the average ERDF operational costs for all projects.

8.1.1 Included Costs

Data presented in this summary are intended to include all project and ERDF costs for excavation and loadout, waste transportation and disposal at ERDF, and backfill and revegetation costs. Costs include fully burdened labor, equipment and materials, and subcontract services.

8.1.2 Excluded Costs

Data presented in this summary exclude up-front costs associated with RI/FS development, initial project conceptual and detailed designs, 100 Area RDR/RAWP (DOE/RL-96-17) development, and subcontract package development. All costs associated with leach or treatability studies were captured under cost accounts for the 100-BC-1 OU designs and are excluded from the values presented in the report.

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**Table 8-1. Summary of Actual Remedial Action and Waste Disposal Costs
for 100-BC-1 Operable Unit Waste Sites. (2 Pages)**

WIDS Site Name	Site Type	Waste Quantity (US tons)	Excavation (\$K)		Waste Treatment/Disposal (\$K)		Total (\$K)
			ERC/RCCC	Subcontract	Soil/Debris	Drums	
100-B-5	Trench	17,950	0 ^a	0 ^a	404.1	0	404.1
100-B-8	Radioactive process sewer	269,742	3,323.7	19.4	6,071.9	0	13,123.8
100-B-12	Storage	0 ^b	2.4	1.2	0.0	0	3.6
100-B-14	Process sewer	37,647.1	291.4	1,662.1	847.8	0	2,801.3
100-B-16	Dumping area	1,870.3	11.5	28.2	42.2	0	81.9
100-B-18	Dumping area	154.7	13	14.6	3.5	0	31.1
100-B-19	Unplanned release	13,821.1	72.6	519.5	311.1	0	903.2
100-B-20	Maintenance shop	0 ^b	2.1	21.7	0.0	0	23.8
100-B-21	Process sewer	1,044.1	97.5	560.9	23.6	0	682
100-B-22	Foundation	83.5	38.8	31.7	1.9	0	72.4
100-B-25	Outfall	6,652	54.3	483	149.7	0	687
100-B-27	Unplanned release	30,864.5	103.9	1,762.1	775.4	0	2,641.4
100-B-28	Product piping	2,596.7	35.8	317.3	58.5	0	411.6
100-B-32	Unplanned release	0.01	3.2	1.1	0.0	0	4.3
100-B-33	Unplanned release	685	14.9	25	15.4	0	55.3
116-B-1	Trench	47,436	327.1	585.7	1,067.8	0	1,980.6
116-B-2	Trench	10,354	83.2	206.4	233.1	0	522.7
116-B-3	Crib	269	65.5	46.3	6.1	0	117.9
116-B-4	French drain	9,590	141.6	355.4	215.9	0	712.9
116-B-5	Crib	122.4	2.5	11.5	2.8	0	16.8
116-B-6A	Crib	5,591	86.6	172.5	234.1	0	493.2
116-B-16	Storage tank						
116-B-6B	Crib	259	49.2	30.7	5.8	0	85.7
116-B-7							
132-B-6	Outfall	18,996	219.7	709.5	427.6	0	1,356.8
132-C-2							
116-B-9	French drain	254	28.3	20.5	5.7	0	54.4
116-B-10	Dry well	763	46.8	64.8	17.2	0	128.8
116-B-11	Retention basin	182,109	972.3	1,712	4,099.3	0	6,783.6
116-B-12	Crib	9,586	66.9	75.7	215.8	0	358.4
116-B-13	Trench	6,989	0	0	157.3	0	157.3
116-B-14	Trench	4,183	0	0	94.2	0	94.2

Table 8-1. Summary of Actual Remedial Action and Waste Disposal Costs for 100-BC-1 Operable Unit Waste Sites. (2 Pages)

WIDS Site Name	Site Type	Waste Quantity (US tons)	Excavation (\$K)		Waste Treatment/Disposal (\$K)		Total (\$K)
			ERC/RCCC	Subcontract	Soil/Debris	Drums	
118-B-5	Burial ground	5,563.1	138.7	171.4	125.2	0	435.3
118-B-10	Storage tank	293	56.6	25.6	6.6	0	88.8
120-B-1	Sump	70.1	14.9	22.8	1.6	0	39.3
126-B-3	Dumping area	122,721.2	237.7	1,632.6	2,762.5	0	4,632.8
128-B-2	Burn pit	13,994.6	74.1	277.6	315.0	0	666.7
128-B-3	Burn pit	46,264.3	123.4	861.3	1,053.9	0	2,038.6
1607-B2	Septic tank	41,455.3	64.9	360.7	933.2	0	1,358.8
1607-B3	Septic tank	0 ^c	0	0	0.0	0	0
1607-B4	Septic tank	0 ^c	0	0	0.0	0	0
1607-B7	Septic tank	218	20	31.3	4.9	0	56.2
116-C-1	Trench	107,514	968.3	1,060.8	2,420.1	0	4,449.2
116-C-5	Retention basin	246,695	1,180.8	2,251.6	5,553.1	0	8,985.5
Totals		1,264,401	9,034.2	19,843.3	28,663.6	0	57,541.1

^a Site was removed as part of 100-C-6 remediation.

^b No waste quantities were generated. The residual concentrations at the waste site meet the remedial action objectives specified in the interim action records of decision.

^c Tank was not removed. Backfilled with rubble or clean material.

ERC = Environmental Restoration Contractor

RCCC = River Corridor Closure Contract

WIDS = Waste Information Data System

Table 8-2. Summary of Actual Remedial Action and Waste Disposal Unit Costs for 100-BC-1 Operable Unit Waste Sites. (3 Pages)

Site Name	Site Type	Excavation Approach	Personal Protective Equipment	Duration (mo) ^a	Waste Quantity (US tons) ^b	Total Cost (\$K) ^c	Average Cost (\$/US ton)
100-B-5	Trench	Direct load	Level D	1	17,950	404.1	22.51
100-B-8	Radioactive process sewer	Stockpile, sort, load	Level D	34	269,742	13,123.8	48.65
100-B-12	Storage	Direct load	Level D	NA	0 ^d	3.6	0
100-B-14	Process sewer	Direct load	Level D	16	37,647.1	2,801.3	74.41
100-B-16	Dumping area	Stockpile, sort, loadout	Level D	2	1,870.3	81.9	43.77
100-B-18	Dumping area	Direct load and 55-gal drums	Level D	1	154.7	31.1	200.92
100-B-19	Unplanned release	Direct load	Level D	7	13,821.1	903.2	65.35
100-B-20	Maintenance shop	B-25 boxes	Level B, D	1	0 ^d	23.8	0
100-B-21	Process sewer	Direct load	Level B, D	23	1,044.1	682	653.21

Table 8-2. Summary of Actual Remedial Action and Waste Disposal Unit Costs for 100-BC-1 Operable Unit Waste Sites. (3 Pages)

Site Name	Site Type	Excavation Approach	Personal Protective Equipment	Duration (mo) ^a	Waste Quantity (US tons) ^b	Total Cost (\$K) ^c	Average Cost (\$/US ton)
100-B-22	Foundation	Stockpile, loadout	Level D	1	83.5	72.4	866.82
100-B-25	Outfall	Stockpile, loadout	Level D	2	6,652	687	103.28
100-B-27	Unplanned release	Direct load	Level D	6	30,864.5	2,641.4	85.58
100-B-28	Product piping	Drain/drum liquids, stockpile, sort, loadout	Level C, D	3	2,596.7	411.6	158.49
100-B-32	Unplanned release	Direct load	Level D	1	0.01	4.3	0
100-B-33	Unplanned release	Stockpile, loadout	Level D	4	685	55.3	80.76
116-B-1	Trench	Direct load	Level D ^e	4	47,436	1,980.6	41.75
116-B-2	Trench	Direct load	Level D ^e	4	10,354	522.7	50.48
116-B-3	Crib	Direct load	Level D ^e	2	269	117.9	438.12
116-B-4	French drain	Direct load	Level D ^e	7	9,590	712.9	74.33
116-B-5	Crib	Direct load ^a	Level D ^e	2	122.4	16.8	136.89
116-B-6A 116-B-16	Crib Storage tank	Direct load	Level D ^e	1	5,591	493.2	88.20
116-B-6B	Crib	Direct load	Level D ^e	1	259	85.7	331.00
116-B-7 132-B-6 132-C-2	Outfall	Direct load	Level D	7	18,996	1,356.8	71.43
116-B-9	French drain	Direct load	Level D	1	254	54.4	214.64
116-B-10	Dry well	Direct load	Level D ^e	3	763	128.8	168.77
116-B-11	Retention basin	Direct load	Level D	12	182,109	6,783.6	37.25
116-B-12	Crib	Direct load	Level D ^e	2	9,586	358.4	37.39
116-B-13	Trench	Direct load	Level D ^e	4	6,989	157.3	22.51
116-B-14	Trench	Direct load	Level D ^e	5	4,183	94.2	22.51
118-B-5	Burial ground	Stockpile, sort, loadout	Level B, C, D	2	5,563.1	435.3	78.25
118-B-10	Storage tank	Stockpile, sort, loadout	Level C, D	1	293	88.8	303.06
120-B-1	Sump	Direct load	Level D	1	70.1	39.3	560.31
126-B-3	Dumping area	Stockpile, stage, sort, loadout	Level B, C, D	4	122,721.2	4,632.8	37.75
128-B-2	Burn pit	Stockpile, sort, loadout	Level B, C, D	6	13,994.6	666.7	47.64

**Table 8-2. Summary of Actual Remedial Action and Waste Disposal
Unit Costs for 100-BC-1 Operable Unit Waste Sites. (3 Pages)**

Site Name	Site Type	Excavation Approach	Personal Protective Equipment	Duration (mo) ^a	Waste Quantity (US tons) ^b	Total Cost (\$K) ^c	Average Cost (\$/US ton)
128-B-3	Burn pit	Stockpile, sort, loadout	Level D	5	46,264.3	2,038.6	44.06
1607-B2	Septic tank	Direct load	Level D	18	41,455.3	1,358.8	32.78
1607-B3	Septic tank	Direct load	Level D	NA	0 ^f	0	0
1607-B4	Septic tank	Direct load	Level D	NA	0 ^f	0	0
1607-B7	Septic tank	Direct load	Level D	1	218	56.2	257.83
116-C-1	Trench	Direct load	Level D	14	107,514	4,449.2	41.38
116-C-5	Retention basin	Direct load	Level D	19	246,695	8,985.5	36.42
Totals					1,264,401	57,541.1	45.51

^a Excavations and loadout durations rounded to the nearest month.

^b Waste quantities as provided in the remaining sites verification package or obtained from Waste Management Information System. Includes bulk soil and debris.

^c All values represent fully burdened costs including applicable direct and indirect (general and administrative) overhead.

^d No waste quantities were generated. The residual concentrations at the waste site meet the remedial action objectives specified in the interim action records of decision.

^e Information was not available. The excavation approach and/or personal protective equipment used during waste site remediation were assumed based on analogous waste site approaches.

^f Tank was not removed. Backfilled with rubble or clean material.

NA = not applicable

Project Cost Summary

Figure 8-1. General Work Breakdown Structure for 100-BC-1 Operable Unit Remediation.

WORK BREAKDOWN STRUCTURE – EXAMPLE WORK SCOPE

1.03 Fld. Rem.-Field Remediation Closure

1.03.01 Fld. Rem.-100-BC Area

1.03.01.02.05 – Field Remediation – Waste Sites - 100-BC-1

1.03.01.02.05.01 Remediate Waste Site - 100-B-16

- 1.03.01.02.05.01.01 Excavation Process
- 1.03.01.02.05.01.02 Loadout
- 1.03.01.02.05.01.03 Backfill
- 1.03.01.02.05.01.04 Closeout Sampling and Documentation
- 1.03.01.02.05.01.05 Revegetation

1.03.01.02.05.18 Remediate Waste Site - 100-B-21

- 1.03.01.02.05.18.01 Excavation Process
- 1.03.01.02.05.18.02 Loadout
- 1.03.01.02.05.18.03 Backfill
- 1.03.01.02.05.18.04 Closeout Sampling and Documentation
- 1.03.01.02.05.18.05 Revegetation

1.03.01.02.05.22 Remediate Waste Site - 100-B-28

- 1.03.01.02.05.22.01 Excavation Process
- 1.03.01.02.05.22.02 Loadout
- 1.03.01.02.05.22.03 Backfill
- 1.03.01.02.05.22.04 Closeout Sampling and Documentation
- 1.03.01.02.05.22.05 Revegetation

1.03.01.02.06 Fld. Rem.-Burial Grounds-100-BC-1

1.03.01.02.06.01 Remediate Burial Ground - 118-B-2

- 1.03.01.02.06.01.05 Revegetation

1.03.01.03.06.01 Remediate Burial Ground - 118-B-3

- 1.03.01.03.06.01.01 Excavation Process
- 1.03.01.03.06.01.02 Loadout
- 1.03.01.03.06.01.04 Closeout Sampling and Documentation
- 1.03.01.03.06.01.05 Revegetation

1.03.01.03.06.02 Remediate Burial Ground - 118-B-6

- 1.03.01.03.06.02.01 Excavation Process
- 1.03.01.03.06.02.02 Loadout
- 1.03.01.03.06.02.04 Closeout Sampling and Documentation
- 1.03.01.03.06.02.05 Revegetation

8.2 COST PRESENTATION

For presentation in this report, actual costs were grouped into the following general categories:

- Remedial action
- ERDF waste treatment and disposal
- Drummed waste treatment and disposal.

Additional information on each of the three general categories is provided in the following subsections.

8.2.1 Remedial Action

Details for remedial action costs are presented in Table 8-3. Remedial action costs are subdivided into ERC/RCC and subcontract costs. The subcontract costs include remedial action subcontractors that supported the work, commercial laboratories, and other miscellaneous subcontracts (e.g., engineering support, training, cultural resources). The remedial actions and backfill subcontracts were all lump-sum, fixed-price contracts.

The WBS for remedial action included site-specific and non site-specific (e.g., project management, engineering, cost control, administration) at the WBS project level. For presentation in this report, remedial action costs captured for nonsite-specific WBSs were not included.

8.2.2 Environmental Restoration Disposal Facility Waste Transportation, Treatment, and Disposal

Details for the ERDF transportation and disposal costs is presented in Table 8-4. Separate costs for transportation/disposal, stabilization, and macroencapsulation of soil and debris are presented based on average unit rates of \$22.51/US ton, \$142.73/US ton, and \$142.73/US ton, respectively. Soil and debris quantities are based on quantities provided in CVP/RSVPs or were obtained from the Waste Management Information System. The transportation/ disposal rate accounts for transport of waste from the 100-BC Area queue to ERDF.

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Table 8-3. Remedial Action Cost Detail for 100-BC-1 Operable Unit Waste Sites. (2 Pages)

Site Name	Site Type	ERC/RCCC (\$K)			Subcontract (\$K)					Total (\$K)
		Labor	Other	Sub-total	Excavation	Backfill/Reveg	Lab	Other	Sub-total	
100-B-5	Trench	0	0	0	0	0	0	0	0	0
100-B-8	Radioactive process sewer	3,312.9	10.8	3,323.7	2,839.70	19.4	844.9	24.2	3,728.2	7,051.9
100-B-12	Storage	2.4	0	2.452	0	0	1.2	0	1.2	3.6
100-B-14	Process sewer	243.9	47.5	291.4	835.8	473.7	334.3	18.3	1,662.1	1,953.5
100-B-16	Dumping area	5.9	5.6	11.5	19.6	1.7	6.9	0	28.2	39.7
100-B-18	Dumping area	7.7	5.3	13	9.6	0	5	0	14.6	27.6
100-B-19	Unplanned release	61.3	11.3	72.6	453	37.6	27	1.9	519.5	592.1
100-B-20	Maintenance shop	2	.1	2.1	21.7	0	0	0	21.7	23.8
100-B-21	Process sewer	76.9	20.6	97.5	375.5	78.8	104.3	2.3	560.9	658.4
100-B-22	Foundation	27	11.8	38.8	14.3	2.1	15.1	0.2	31.7	70.5
100-B-25	Outfall	48.7	5.6	54.3	367.6	71.5	41.3	2.6	483	537.3
100-B-27	Unplanned release	92.6	11.3	103.9	1,395.8	318.7	39.7	7.9	1,762.1	1,866
100-B-28	Product piping	25.4	10.4	35.8	204.9	50.3	58.7	3.4	317.3	353.1
100-B-32	Unplanned release	2	1.2	3.2	0.01	0.02	1	0.07	1.1	4.3
100-B-33	Unplanned release	12.7	2.2	14.9	4.9	0.8	19.2	0.1	25	39.9
116-B-1	Trench	281.5	45.6	327.1	340.2	163.6	81.3	0.6	585.7	912.8
116-B-2	Trench	76.9	6.3	83.2	126.7	23	56.7	0	206.4	289.6
116-B-3	Crib	43.7	21.8	65.5	22.4	0.8	23.1	0	46.3	111.8
116-B-4	French drain	133.8	7.8	141.6	217.5	74.5	58.3	5.1	355.4	497
116-B-5	Crib	2.5	0	2.5	0	11.2	0	0.3	11.5	14
116-B-6A 116-B-16	Crib storage tank	66.3	20.3	86.6	110.3	11.5	50.7	0	172.5	259.1
116-B-6B	Crib	23.8	25.4	49.2	8.9	0.8	21	0	30.7	79.9
116-B-7 132-B-6 132-C-2	Outfall	218.9	0.8	219.7	535.5	85.5	88.4	0.1	709.5	929.2
116-B-9	French drain	20.6	7.7	28.3	4.1	0.6	15.8	0	20.5	48.8
116-B-10	Dry well	35.9	10.9	46.8	27.7	1.5	35.6	0	64.8	111.6
116-B-11	Retention basin	962.1	10.2	972.3	936.6	610	158.2	7.2	1712	2,684.3
116-B-12	Crib	57	9.9	66.9	59.6	5.5	10.5	0.1	75.7	142.6
116-B-13	Trench	0	0	0	0	0	0	0	0	0
116-B-14	Trench	0	0	0	0	0	0	0	0	0
118-B-5	Burial ground	133.3	5.4	138.7	117	4.9	47.8	1.7	171.4	310.1

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Table 8-3. Remedial Action Cost Detail for 100-BC-1 Operable Unit Waste Sites. (2 Pages)

Site Name	Site Type	ERC/RCCC (\$K)			Subcontract (\$K)					Total (\$K)
		Labor	Other	Sub-total	Excavation	Backfill/Reveg	Lab	Other	Sub-total	
118-B-10	Storage tank	54.8	1.8	56.6	6.4	0.4	18.5	0.3	25.6	82.2
120-B-1	Sump	12	2.9	14.9	17.4	0	5.3	0.1	22.8	37.7
126-B-3	Dumping area	222.4	15.3	237.7	1,263	291	78.3	0.3	1,632.6	1,870.3
128-B-2	Burn pit	61.4	12.7	74.1	175.7	22.5	77.8	1.6	277.6	351.7
128-B-3	Burn pit	101.9	21.5	123.4	723.1	18	117.7	2.5	861.3	984.7
1607-B2	Septic tank	55.4	9.5	64.9	217.2	47.7	95.1	0.7	360.7	425.6
1607-B3	Septic tank	0	0	0	0	0	0	0	0	0
1607-B4	Septic tank	0	0	0	0	0	0	0	0	0
1607-B7	Septic tank	19.4	0.6	20	12.5	0	18.8	0	31.3	51.3
116-C-1	Trench	788.5	179.8	968.3	509.1	329.7	170.9	51.1	1,060.8	2,029.1
116-C-5	Retention basin	1,178.6	2.2	1,180.8	1,240.3	792.4	169.8	49.1	2,251.6	3,432.4
Totals		8,472.1	562.1	9,034.2	13,213.6	3,549.7	2,898.2	181.8	19,843.3	28,877.5

ERC = Environmental Restoration Contract

RCCC = River Corridor Closure Contract

ERC/RCCC Summary

Labor – includes project management, field engineering, environmental, safety, radcon, sampling, data management, project controls, excavation and loadout, backfill, revegetation and site closeout; excludes project design, subcontract development, mobilization, and work plan development

Other – equipment and supplies.

Subcontract Summary

Excavation – remedial action subcontractor labor (project management, safety, supervision, craft, administration), equipment, supplies, excavation, and loadout

Backfill/Reveg – backfill and revegetation subcontractor labor (project management, safety, supervision, craft, administration), equipment and supplies

Lab – contract laboratory sample analysis and reporting for waste characterization, site closeout, and air monitoring

Other – miscellaneous support subcontract costs (engineering support, training, and cultural resources).

Table 8-4. Environmental Restoration Disposal Facility Transportation, Treatment, and Disposal Cost Detail for 100-BC-1 Operable Unit Waste Sites. (2 Pages)

Site Name	Site Type	Soil and Debris Quantity (US tons)				ERDF Cost (\$K)			
		Nonhazardous Soil/Debris (Direct Disposal)	Hazardous Soil (Stabilization)	Hazardous Debris (Macro)	Total	Transportation/ Disposal	Stabilization	Macro	Total
100-B-5	Trench	17,950	0	0	17,950	404.1	0.0	0.0	404.1
100-B-8	Radioactive process sewer	269,742	0	0	269,742	6,071.9	0.0	0.0	6,071.9
100-B-12	Storage	0	0	0	0 ^a	0.0	0.0	0.0	0.0
100-B-14	Process sewer	37,643.7	0	3.4	37,647.1	847.4	0.0	0.5	847.8
100-B-16	Dumping area	1,869.7	0	0.5	1,870.3	42.1	0.0	0.1	42.2
100-B-18	Dumping area	154.7	0	0	154.7	3.5	0.0	0.0	3.5
100-B-19	Unplanned release	13,821.1	0	0	13,821.1	311.1	0.0	0.0	311.1
100-B-20	Maintenance shop	0	0	0	0 ^a	0.0	0.0	0.0	0.0
100-B-21	Process sewer	1,043.2	0	0.93	1,044.1	23.5	0.0	0.1	23.6
100-B-22	Foundation	83.5	0	0	83.5	1.9	0.0	0.0	1.9
100-B-25	Outfall	6,652	0	0	6,652	149.7	0.0	0.0	149.7
100-B-27	Unplanned release	30,193.6	670.8	0.1	30,864.5	679.7	95.7	0.0	775.4
100-B-28	Product piping	2,596.7	0	0	2,596.7	58.5	0.0	0.0	58.5
100-B-32	Unplanned release	0.01	0	0	0.01	0.0	0.0	0.0	0.0
100-B-33	Unplanned release	685	0	0	685	15.4	0.0	0.0	15.4
116-B-1	Trench	47,436	0	0	47,436	1,067.8	0.0	0.0	1,067.8
116-B-2	Trench	10,354	0	0	10,354	233.1	0.0	0.0	233.1
116-B-3	Crib	269	0	0	269	6.1	0.0	0.0	6.1
116-B-4	French drain	9,590	0	0	9,590	215.9	0.0	0.0	215.9
116-B-5	Crib	122.4	0	0	122.4	2.8	0.0	0.0	2.8
116-B-6A	Crib	4,691	0	900	5,591	105.6	0.0	128.5	234.1
116-B-16	storage tank								
116-B-6B	Crib	259	0	0	259	5.8	0.0	0.0	5.8
116-B-7									
132-B-6	Outfall	18,996	0	0	18,996	427.6	0.0	0.0	427.6
132-C-2									
116-B-9	French drain	254	0	0	254	5.7	0.0	0.0	5.7

Table 8-4. Environmental Restoration Disposal Facility Transportation, Treatment, and Disposal Cost Detail for 100-BC-1 Operable Unit Waste Sites. (2 Pages)

Site Name	Site Type	Soil and Debris Quantity (US tons)				ERDF Cost (\$K)			
		Nonhazardous Soil/Debris (Direct Disposal)	Hazardous Soil (Stabilization)	Hazardous Debris (Macro)	Total	Transportation/ Disposal	Stabilization	Macro	Total
116-B-10	Dry well	763	0	0	763	17.2	0.0	0.0	17.2
116-B-11	Retention basin	182,109	0	0	182,109	4,099.3	0.0	0.0	4,099.3
116-B-12	Crib	9,586	0	0	9,586	215.8	0.0	0.0	215.8
116-B-13	Trench	6,989	0	0	6,989	157.3	0.0	0.0	157.3
116-B-14	Trench	4,183	0	0	4,183	94.2	0.0	0.0	94.2
118-B-5	Burial ground	5,563	0	0.1	5,563.1	125.2	0.0	0.0	125.2
118-B-10	Storage tank	293	0	0	293	6.6	0.0	0.0	6.6
120-B-1	Sump	70.1	0		70.1	1.6	0.0	0.0	1.6
126-B-3	Dumping area	122,720.8	0	0.4	122,721.2	2,762.4	0.0	0.1	2,762.5
128-B-2	Burn pit	13,994.6	0	0.04	13,994.6	315.0	0.0	0.0	315.0
128-B-3	Burn pit	46,160.7	103.6	0	46,264.3	1,039.1	14.8	0.0	1,053.9
1607-B2	Septic tank	41,455.3	0	0	41,455.3	933.2	0.0	0.0	933.2
1607-B3	Septic tank	0	0	0	0 ^b	0.0	0.0	0.0	0.0
1607-B4	Septic tank	0	0	0	0 ^b	0.0	0.0	0.0	0.0
1607-B7	Septic tank	218	0	0	218	4.9	0.0	0.0	4.9
116-C-1	Trench	107,514	0	0	107,514	2,420.1	0.0	0.0	2,420.1
116-C-5	Retention basin	246,695	0	0	246,695	5,553.1	0.0	0.0	5,553.1
Totals		1,262,721	774.4	905.4	1,264,401	28,423.9	110.5	129.2	28,663.6

^a No waste quantities were generated. The residual concentrations at the waste site meet the remedial action objectives specified in the interim action records of decision.

^b Tank was not removed. Backfilled with rubble or clean material.

ERDF = Environmental Restoration Disposal Facility

Macro = macroencapsulation

8.3 DISCUSSION

Several factors contribute to the unit cost values presented in Table 8-2. The following subsections summarize some of the major factors and trends observed in the cost data presented in this report.

8.3.1 Small Waste Sites

Unit costs for the small soil contamination sites (100-B-18, 100-B-22, 116-B-3, 116-B-6B, 116-B-9, 118-B-10, 1607-B7, and 120-B-1) were among the highest observed, ranging from

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approximately \$200 to \$867/US ton. The major factor in the high relative unit cost for these sites was the short excavation and loadout duration, which were typically a month or less for each site, and small waste quantities typically less than 250 US tons. Although the majority of the work was performed in Level D PPE, there were occasions where PPE was upgraded to Level C depending on anomalous conditions and radiological controls. Although direct loadout was allowed for these sites, there may have been times when ERDF containers were not available, and the subcontractor had to temporarily stage material.

8.3.2 Large Liquid Waste Sites

The lowest unit costs were observed for the larger liquid waste sites such as the 116-C-5 waste site. Unit costs for these sites ranged from \$23 to \$86/US ton. The major factors contributing to the lower relative unit cost for these sites include the following:

- Longer excavation/loadout durations (6 to 20 months) that permitted more effective amortization of mobilization and demobilization costs.
- The general absence of anomalous waste. Since contaminant distribution at liquid sites tends to be more uniform and predictable, work was performed in Level D PPE and the subcontractor was allowed to excavate and load waste directly into roll-off containers for transport to the ERDF.
- Excavation and loadout rates were predictable and driven by the heavy equipment and the daily allotment of roll-off containers.

The primary challenge for several of the liquid waste sites were the amount overburden required to be removed to access the contamination or pipelines, which increased average costs.

8.3.3 Burial Grounds and Dumping Areas

Unit costs for burial grounds and dumping areas ranged from \$23 to \$78/US ton. The larger sites tended to be on the lower range while the smaller sites tended to be on the upper range. The greatest influence on the unit cost for these sites was the potential to encounter anomalous waste. This potential and the inability to reliably predict where or when anomalous waste would be encountered resulted in the following work controls:

- Use of Level B PPE (supplied air respirators, chemically resistant protective clothing). Use of the Level B PPE increased the potential for heat stress in warm weather conditions and decreased worker productivity. The cost impact for Level B operations was the greatest for the first sites excavated with these controls. As experience was gained, a graded approach to Level B operations was developed and implemented that reduced the number of personnel in protective gear and increased productivity.

- Waste sorting and stockpiling. Waste excavated from the burial grounds and landfills had to be sorted to identify and remove anomalies, stockpiled, sampled, and released before the subcontractor was allowed to load the material into roll-off containers for transport to ERDF. This requirement resulted in double handling of all excavated material, the need for additional personnel (craft labor, radiological control technicians, and samplers), and decreased overall productivity.

Production rates for the burial grounds and dumping areas were much less predictable than liquid waste sites. Rather than being driven by equipment and roll-off container allotment, rates were variable depending on the type of material being excavated and amount of anomalous waste encountered.

Factors that influenced costs include duration, size of the burial ground, total depth of the burial ground, and if the excavated material had to be staged and sorted prior to loadout to ERDF.

8.4 COMPARISON OF ESTIMATED AND ACTUAL COSTS

Recognizing that the ROM cost estimates provided in the interim action RODS and summarized in Section 2.0 have not been escalated to reflect present-value dollars, some general conclusions can be made in comparing ROM costs to the actual costs presented in this report. For the majority of the remediated waste site in the 100-BC-1 OU, the actual costs were significantly lower than those estimated in interim action RODS and are outside the ROM estimate of accuracy (+50% to -30%). The total ROM costs for remediation of the 100-BC-1 OU waste sites was estimated at \$208.9 million including estimated confirmatory sampling costs. The actual cost of remediation as shown in Table 8-3 totaled \$57.5 million excluding confirmatory sampling costs.

There are several factors that contribute to the differences and difficulty in comparing the estimated and actual costs. These factors are discussed below:

- The *Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1 and 100-HR-1 Operable Units, Hanford Site, Benton County, Washington* (EPA 1997) reduced the estimated costs of remediation for the original 37 sites identified from \$491 million to \$82 million or an 83% reduction. Of the 37 sites, a total of 17 sites were located within the 100-BC-1 OU. However, the costs reductions were not identified on a site-specific basis making comparison of estimated and actual costs difficult. The original remedial action costs identified in the 1995 Interim Action ROD for waste sites 100-B-8, 116-B-11, 116-C-1, and 116-C-5 totaled approximately \$188 million.
- The disparity between actual and estimated costs can be attributed, in part, to encountering lower quantities of contaminated soil than was estimated in the interim action RODs. The total estimated disposal volume for the 100-BC-1 OU waste sites based on estimates provided in the interim action RODs was 1,615,745 US tons while the actual disposal volume

was 1,264,401 US tons. The volumes identified in the interim action RODs were based on limited site characterization data and assumed worst-case conditions.

- Remediation costs and quantities were not necessarily provided on a site-specific basis for “additional candidate” sites that failed confirmatory sampling and therefore required remediation. Costs were estimated based on an assumed failure rate for the entire group of sites within a specific ESD.
- The costs for ERDF waste transportation and disposal identified in Table 8-4 were based on the 2011 disposal rates of \$22.51/ton. ERDF disposal rates vary on a yearly basis and were \$33.30/ton in 2009. The difference in the transportation and disposal rate can therefore vary by more than \$10/ton in any given year and when applied to the actual disposal volume of 1,264,401 tons could result in a potential costs difference of more than \$12 million.
- The planned cost for ERDF waste transportation and disposal provided in the interim RODs is higher than the actual ERDF disposal costs. The difference between the planned cost of \$70/cubic yard and the 2011 ERDF disposal cost of \$22.51/ton, which converts into \$43.21/cubic yard, results in a decrease of 38%.
- Costs and disposal quantities for some sites were included with co-located waste sites. For example, the 100-B-8 waste site remediation included pipelines that were remediated in both the 100-BC-1 and 100-BC-2 OU areas. In addition, the remediation of the 100-B-8 waste site included the remediation of the 100-C-6 waste site. For the purpose of this report, the 100-B-8:1 quantity and costs that reflect the remedial activities in the northern part of the 100-BC area were included in this report. The costs and quantities associated with the 100-B-8:2 site will be included with the 100-C-6 waste site located in the 100-BC-2 OU which captured quantities and costs for remedial activities in the southern part of the 100-BC area.

8.5 FUTURE USE OF COSTS

Costs presented in this report have not been escalated to reflect present-value dollars. Future users of the cost data should be cautioned that escalation adjustments may be needed to provide meaningful information, depending on the intended use.

9.0 OBSERVATIONS AND LESSONS LEARNED

This report of the remediation of 100-BC-1 OU waste sites provides an opportunity to identify project successes, areas for improvement, and lessons learned. The prime contractors, subcontractors, DOE, DOE-RL, and EPA successfully worked together to adapt to changing and unexpected conditions that were presented during remedial action operations. In doing so, the work was performed safely without any lost-time injuries.

The burial grounds, liquid waste sites, and soil contamination sites fit the subcontract structure well. Remedial action operations at those sites were performed efficiently by the project teams. Special methods were developed for a wide variety of anomalous items encountered during remediation, which required adjustment to the work scope and subcontracting approaches.

Lessons learned from remedial activities in the 100-BC-1 OU were related to the anomalous waste materials that were encountered in the burial ground trenches; other issues were related to safety and operational challenges. Although most lessons learned are generated as a result of radiological events or safety issues, there are occasions when a lesson learned is generated based on positive feedback from a process improvement and include the following:

- **Multiple Work Activities in Close Proximity.** Early mobilization to the site by one subcontractor resulted in interferences with on-going work scope being performed by another subcontractor in close proximity of each other. This resulted in a lack of productivity due to problems associated with conflicting work activities.
- **Remediation of Nonregulated Waste Site.** A small stained patch of ground from pre-Hanford farming operations, presumed to be oil, was discovered near the 100-BC-1 OU and reported as a discovery site. Sampling indicated that the soil contained greater than 200 parts per million total petroleum hydrocarbons which is an MTCA (WAC 173-340) cleanup level. The soil was, however, nonregulated in the sense that it was a solid waste that did not exhibit dangerous characteristics and was not specifically listed in regulations as dangerous waste. Once it was determined through sampling and analysis that the site contained nonregulated waste, an alternative was found that saved time and as much as \$30,000 in remediation cost.

Another unique lesson learned was apparent during the development of this and previous remedial action reports, and is likely only applicable to large project sites where remedial activities span many years and subcontractors. Obtaining cost data from remedial activities that spanned almost 10 years and two different DOE subcontracts can be difficult and time consuming. Changes or upgrades in cost accounting structures and software can impede the retrieval of accurate remedial action costs for older data. If readily available, it is recommended that cost data be captured at the time the waste site-specific remedial activities are completed to eliminate potential issues during the development of future remedial action reports.

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